

ANNALS OF OTOLOGY, RHINOLOGY AND LARYNGOLOGY

VOL. 51

MARCH, 1942

No. 1

I

A MODERN CONCEPTION OF THE PATHOLOGY, DIAGNOSIS AND TREATMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA*

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Chronic suppurative otitis media is a comparatively common condition in many sections of the country; in 1940 the number of cases seen in the clinics of the New York Eye and Ear Infirmary¹ was 530, while the number of cases of acute suppurative otitis media was 790. While the number of cases of acute otitic infection during 1940 was considerably less than in previous years because of the mildness of the type of upper respiratory infection prevalent throughout the year, the figures still indicate that chronic purulent otitis media is not by any means a rare disease.

Of more importance is the fact that it is a disease which is often given little attention even by otolaryngologists, and most certainly by the average practitioner; even in quite active clinics the patient with the chronic "running ear" is all too often given a cursory examination and dismissed with some type of antiseptic ear drop for home use. This is true because there is a widespread lack of appre-

*Read for the author in his absence for active duty in the Medical Corps of the U. S. Naval Reserve at the meeting of the Southern Section of the American Laryngological, Rhinological and Otological Society, Inc., Atlanta, Ga., Jan. 23, 1942.

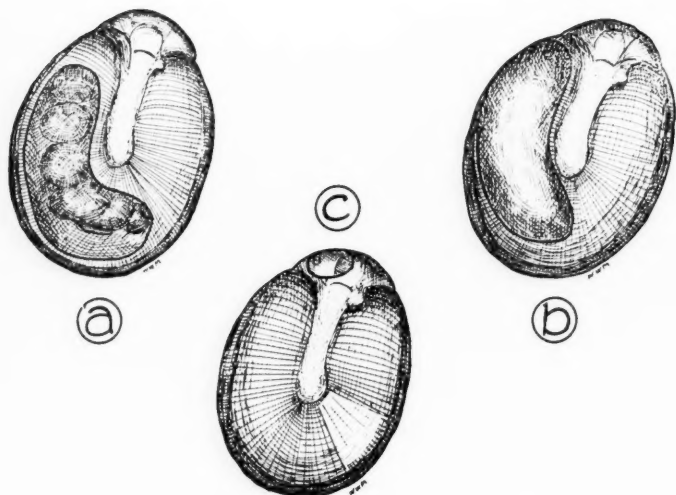


Fig. 1.—The types of chronic perforation of the drum seen in chronic suppurative otitis media.

a. Large central perforation involving anterior and posterior halves of the drum in pars tensa, with granulation tissue on the inner wall of the tympanum. The perforation is central because it does not reach the annulus tympanicus at any point.

b. Large marginal perforation chiefly in the posterior half of the pars tensa of the drum, which is marginal because there has been a destruction of the annulus tympanicus and margin of the drum above and posteriorly.

c. Attic perforation into posterior part of attic through pars flaccida of the drum. May readily be missed unless careful examination of the drum is made. It is marginal because there is no annulus tympanicus at the margin of the pars flaccida.

ciation of the truly serious nature of the common form of this condition, which can be well compared with a sword hanging over the patient's head. It is only now and then that the practitioner is given a revelation of the true significance of the disease by the sudden and dramatic occurrence of a serious intracranial infection which arises in a few hours or a day, when an acute exacerbation of the chronic suppuration leads to a life-threatening complication. The doctor faced with this situation begins to realize that the ear suppuration, with its nuisance of foul-smelling discharge, was by no means harmless, but that it was a chronic disease preparing the route of invasion for acute infection to reach the meninges, the brain, the internal ear, or the lateral cranial venous sinus.

There are two chief types of chronic suppurative otitis media:

- (1) The less-common form presents a central perforation of the pars tensa of the tympanic membrane, of varying form, size, and location (Fig. 1a) and with or without granulation tissue or an aural polyp in the tympanum; these factors are unimportant when compared with the essential fact that at no point does the perforation involve the actual margin of the drum because of a destruction of the annulus tympanicus. This is the fibrous supporting incomplete ring by which the pars tensa of the drum is attached to the bony auditory canal. This is the nondangerous form of the disease.
- (2) The common type presents a perforation of variable size, form, and location, which is marginal at some point or over some portion of its extent (Fig. 1b). The annulus tympanicus has been destroyed, and thereby the barrier to the ingrowth of stratified squamous epithelium from the external auditory canal into the middle ear and mastoid antral spaces is removed. With this ingrowth a cholesteatoma will form, and it is this expanding tumorlike mass which causes this type to be the dangerous form of the disease. It is the cholesteatoma which brings about the avenues for the spread of infection to the intracranial structures. The marginal perforation may lie in the anterior or posterior parts of the pars tensa of the drum, or there may be a total defect of the pars tensa; and perforations of the pars flaccida, or attic perforations. (Fig. 1c), are always to be regarded as marginal and certain to give rise to cholesteatoma.

The pathology of these two forms deserves a more extended description. To begin with, the one essential point in the pathologic changes in the central perforation which fully explains its nondangerous character is that enough of the drum remains all about the periphery of the perforation to act as a barrier to the ingrowth of the stratified squamous epithelium of the skin of the external auditory canal into the tympanic cavity and tympanic attic spaces. These structures continue to be lined with mucosa, which may show any or all of the changes of a chronic infection, including the formation of granulation tissue after loss of the surface epithelium, and polyp formation by the organization of such granulation tissue (Fig. 2a). Since no squamous epithelium can invade the middle ear spaces, and extend into the mastoid antrum through the aditus, a cholesteatoma cannot form. The process remains a strictly localized infection of the mucosa of the middle ear and mastoid antrum, and as such cannot cause the serious intracranial complications mentioned.

In the forms with marginal perforation, however, the pathologic changes are essentially different. The loss of the annulus tym-

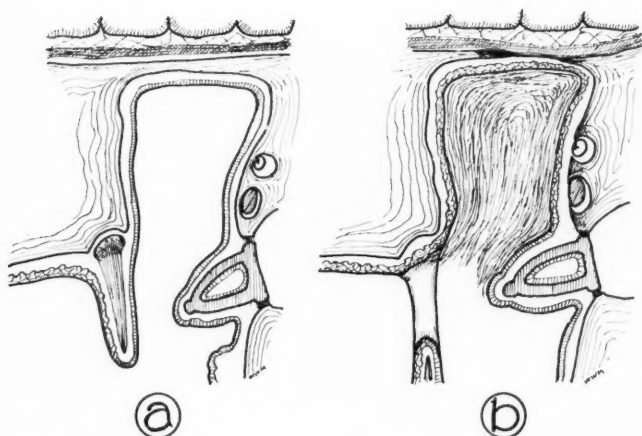


Fig. 2.—Semidiagrammatic vertical sections of the upper part of the tympanum and tympanic attic illustrating the essential pathology of central and marginal drum perforations.

a. A central perforation of the drum. The margin has not been destroyed and acts as a barrier to ingrowth of the squamous epithelium on the external surface of the drum, to replace the mucosa of the inner surface of the drum, the tympanum, tympanic attic and mastoid antrum. The squamous epithelium and the columnar epithelium of the tympanic mucosa meet at the margin of the perforation.

b. A marginal perforation of the drum with cholesteatoma. The margin of the drum and the annulus tympanicus have been destroyed. Squamous epithelium has grown in to replace the mucosa of the tympanic attic. The desquamation from the skin-like lining is trapped in the confines of the tympanic attic to form the cholesteatoma. Its pressure has caused bone absorption of the dural plate in the tympanic tegmen to expose the dura mater, of the membranous horizontal semicircular canal, and of the facial nerve in the horizontal portion of its canal.

panicus allows the direct ingrowth of the squamous epithelium into the tympanum, the attic, and from it through the aditus at last to line completely the mastoid antrum as well (Fig. 2b). This ingrowth always takes place; it is Nature's attempt to cure the supuration in the mucosal lined cavities by replacing it with stratified squamous epithelium, which is resistant to further infection. When such epithelization of all the tympanic and mastoid air spaces is complete, cure of the mucosal suppuration is achieved, but the epithelial lining of the enclosed spaces of the attic and mastoid antrum behaves as does all squamous epithelium, by constantly producing new epithe-

lial cells in its deep layers and casting off the more superficial layers as desquamation. These desquamated cells are trapped within the bony confines of the attic or mastoid antrum to constitute a cholesteatoma, so called because cholesterol crystals are usually found among the layers of desquamated epithelial cells. There is thus formed an ever-growing mass which can expand only at the expense of the surrounding bone by pressure atrophy and the activity of osteoclasts. The cholesteatoma acts like an expanding tumor; the bone atrophy can be so complete in one or more areas that the dura mater in the middle or posterior cranial fossa, the lateral venous sinus, the membranous labyrinth as in the horizontal semicircular canal, or the facial nerve in its canal, open directly into the expanded mastoid antrum or tympanic attic. These areas are the pre-formed paths whereby infection can attack and enter the important structures lying within. Such infection usually enters during an acute exacerbation of the chronic suppuration. This is nothing more than the entrance of fresh infection by virulent bacteria which have ascended the eustachian tube from the nasopharynx during an acute upper respiratory infection or streptococcic pharyngitis, or through the open perforation with water while swimming. This fresh infection at once produces pus formation in quantity and causes the cholesteatoma to swell markedly; the pus cannot readily escape about the cholesteatoma, and under the resultant back pressure, the virulent organisms present readily and quickly attack the exposed dura, sinus, labyrinth, or facial nerve. The infection may quite quickly spread through dural barriers to cause a suppurative meningitis, a brain abscess, a lateral sinus thrombosis with sepsis, a spreading purulent labyrinthitis often leading to meningitis, or a facial nerve paralysis. These intracranial infections may readily kill the patient, despite surgical attack and chemotherapy.

That the danger of intracranial complications is not at all imaginary may be seen from such statistics as those of Haymann² in Denker and Kahler, in which he shows that the percentage of occurrences of sigmoid sinus thrombosis in a very large collection of cases was somewhat greater with chronic otitic suppuration than with acute infection. The figures of Heine and Beck³ in Denker and Kahler, compiled from a number of authors all over the world, show that otitic brain abscess occurs with chronic suppurative otitis media in from 75 to 94 per cent of the cases, while in another series of cases of various authors, from 65 to 87 per cent of the cases of brain abscess and chronic otitis showed a cholesteatoma as the cause of the brain abscess. Hinsberg,⁴ in the same source, reveals that acute spreading suppurative labyrinthitis which leads to meningitis and

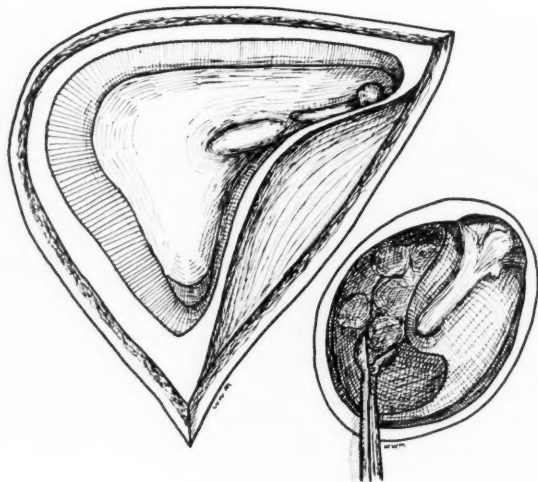


Fig. 3.—The expanded "simple" type of mastoidectomy sometimes performed in children with chronic suppurative otitis media with a small cholesteatoma.

The mastoid antrum and any mastoid cells present are widely opened. The external wall of the tympanic attic is removed to expose the attic spaces and the head of the malleus and long process of the incus. Gauze is packed firmly into these spaces through the mastoid wound and replaced, until granulation tissue completely obliterates the opening from the attic into the tympanum below. No canal plastic is done.

Granulation tissue on the inner wall of the tympanum is removed with delicate forceps through the external canal in the usual way.

causes 75 per cent of the deaths from labyrinthitis, and quotes Jansen who had 137 patients with suppurative labyrinthitis, in whom 134 had chronic ear suppuration, while Schmiegelow had 38 out of 42 cases of labyrinthitis follow chronic otitis media, concludes that this serious form of labyrinthitis was from 10 to 30 times more likely to follow chronic aural suppuration than acute otitis. The findings of a further series of authors show there was cholesteatoma in more than 75 per cent of the cases of labyrinthitis following chronic otitis. Surely these otherwise dry-as-dust statistics should convince us of the possibility of serious intracranial complications from chronic suppurative otitis media with cholesteatoma.

From what has been said regarding the importance of the type of drum perforation as an indicator of the nature of the pathology in any given case, it is obvious that a minute examination of the tympanic membrane is the first essential in an accurate diagnosis. The canal and the drum must be completely cleansed of every trace of cerumen, desquamated skin, wet or dry secretion, and other foreign material by the use of cotton applicators, ring curette, delicate forceps, or the sterile boric acid douche. Every portion of the drum, especially its margin, and the entire pars flaccida must be clearly visualized through the ordinary ear speculum with reflected light, and by means of the electric otoscope with a magnifying lens so that the smallest details may be studied. If granulation tissue protrudes from within the tympanum so as to hide the margin of the perforation for any of its extent, the tissue must be anesthetized and removed with delicate punch forceps or curette until the perforation can be fully seen. An aural polyp will completely hide the perforation, and must be removed with an ear snare before the drum can be adequately studied.

If it is seen that the perforation is certainly central, all that is necessary to complete the diagnosis is a study of radiographs of the mastoid area, in which it will almost always be seen that the mastoid process is only slightly or not at all pneumatized, that there are chronic mucosal thickenings of the cells and mastoid antrum, and that the latter is not pathologically dilated.

If the perforation is marginal, further investigation must be directed toward proof of the presence of cholesteatoma in the tympanic attic or mastoid antrum or both. This is done after anesthetizing the drum by passing a delicate probe, very small ring curette, or cotton applicator up into the attic and back through the aditus into the mastoid antrum through the perforation, and fishing out some of the material found there. Rubbed on a microscope slide, this debris will be seen to be a greasy material mixed with pus, of a peculiar, penetrating, and very foul odor. A stained smear will reveal sheets of hornified, desquamated squamous epithelial cells and crystals of cholesterol which resemble panes of window glass lacking one corner. Another means of diagnosis is the douching of the attic and mastoid antrum with 50 per cent alcohol through a slender attic cannula. The return flow will reveal greasy scales resembling onion skin, which float on the surface of the solution, and have the characteristic foul odor, while pus and debris sink to the bottom of the basin. In addition, radiographs of the mastoid area will almost as a rule reveal that pneumatization of the mastoid process is minimal

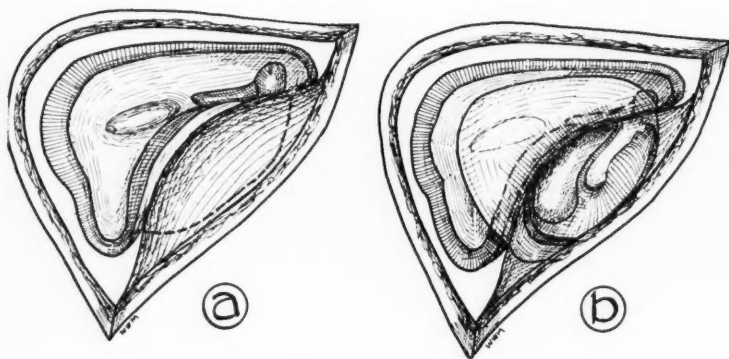


Fig. 4.—The modified radical mastoidectomy with "fenestration" type of canal flap.

a. Usual modified radical cavity with complete removal of external attic wall to expose attic and upper part of malleus and incus. The bony posterior canal wall has been removed down to the level of the annulus tympanicus without traumatizing the membranous posterior and superior canal wall.

b. Circular flap cut from membranous canal wall with attached base at the level of the annulus tympanicus, folded upward and backward into the tympanic attic and mastoid antrum. Light packing through the meatus of the canal into the cavity holds the flap in position until it becomes adherent.

or totally absent, and that the mastoid antrum is pathologically enlarged by the pressure of the contained cholesteatoma.

The physical diagnosis is completed by applying the fistula test to demonstrate the presence of fistula into the membranous labyrinth; if there is a history of one or more severe attacks of vertigo in the past, the function of the labyrinth should be examined by the usual tests, to determine the presence of a damaged or dead labyrinth before any surgical attack is performed.

If the patient is first seen during an acute exacerbation there will be more difficulty in making an accurate diagnosis. The history of the aural condition in the past is all important; without it, one may be easily misled to a diagnosis of acute otitis media and mastoiditis by the pain, free purulent discharge, low grade fever, and by the appearance of the drum, which may be intensely congested and

edematous, so that with swelling of the mucosa of the tympanum, one may gain the idea that there is only an acute process with a bulging and perforated drum. With the history of past suppuration, perhaps years previously, one must make the most careful inspection of the cleansed drum, applying epinephrine to reduce the congestion and swelling, so that the actual margins of the perforation may be seen. If this is done, it will soon be found that there really is a permanent perforation which is or is not marginal, and the true nature of the condition will be understood.

Some of these patients may go for months or years without any appreciable amount of discharge from the middle ear. In such cases there may be only a small but exceedingly foul-smelling crust of dried secretion adherent to the edge of the perforation; or one may be able to demonstrate a little watery secretion of characteristic odor by passing a cotton applicator into the tympanic attic or aditus. In these cases, the name chronic suppurative otitis seems a misnomer; one should not be lulled into a false sense of security in such a situation, for if one can demonstrate the presence of a cholesteatoma, the amount of discharge per se is unimportant; the condition is nevertheless a dangerous one, and steps to prevent serious complications should be advised, and taken if possible.

The repeated mention of the great need for the differentiation between the two chief types is justified immediately when we come to consider the treatment. To put it briefly, the proper care of the nondangerous type with the central perforation is conservative, medical local treatment of the ear, not surgical interference; the proper treatment of the dangerous form with the marginal or attic perforation with cholesteatoma is entirely surgical; any other form of care is merely palliative, since it cannot succeed in completely removing the dangerous cholesteatoma and in preventing its re-formation.

To consider the treatment of the nondangerous form in detail, it is to be noted that we rely chiefly on cleansing and local antiseptic applications. If there is free discharge, boric acid solution douching one or more times daily may be used; the canal must be carefully dried after each douche to prevent skin excoriation. Antiseptic, evaporating drops such as 50 per cent alcohol should be used by the patient once or twice daily. He must be instructed to lie down on the unaffected side, to drop enough solution into the ear to fill the canal, and to lie still for at least ten minutes before allowing the solution to run out again. Office treatment consists in careful cleansing of the canal and the perforation with dry cotton applicators, the

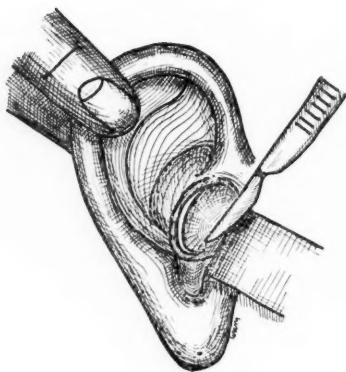


Fig. 5.—Creation of external limit of canal flap by curved incision just within concha, missing the free edge of the conchal cartilage. The anterior and posterior curved limits of the flap are created with a plastic scissors by cuts from the ends of this incision within the concha, inward to the level of the annulus tympanicus.

inflation of the auditory tube to blow out secretion, and the insufflation through the perforation of either 1 per cent iodine in very finely powdered boric acid, or powdered sodium sulfathiazole or sulfadiazine. In addition it is very important that any and all forms of acute and chronic infection in the nose, nasal sinuses, nasopharynx, and pharynx may be dealt with in appropriate manner; persistence of suppuration in a maxillary sinus or the ethmoid cells will often keep up the ear suppuration for a long time. Hypertrophied and infected lymphoid tissue in the nasopharynx and pharynx, particularly adenoid remnants and infected lateral pharyngeal folds, must always be removed; they are perhaps the greatest single source of reinfection in the chronic aural suppurations of children.

When an aural polyp or exuberant granulation tissue protrudes through the perforation, it should be removed to promote free drainage. A polyp should be removed under local or general anesthesia with the aural snare; granulation tissue must be removed with small punch forceps, or ring curette, followed by cauterization with solid silver nitrate or chromic acid under local anesthesia, using great care not to cauterize surrounding structures.

The details of the treatment of the dangerous form with marginal perforation and cholesteatoma must now be discussed fully. Every patient with a proved case of this type should be offered operation which is the only certain cure; it is the strong conviction of the author that operation is always indicated in the presence of cholesteatoma. One must explain to the patient or some responsible member of his family the actual and potential dangers of the condition, and of the impossibility of removing the danger by any method other than operation. All other forms of treatment with douching, antiseptic drops, insufflation of antiseptic powders, medication with sulfonamide drugs, ionization of the tympanum with zinc, the use of urea, etc., cannot completely remove the cholesteatoma and hence are purely palliative.

The aim of the surgical treatment is twofold. First one must completely remove the cholesteatoma; second, one must prevent its re-formation forever. Both of these aims must be achieved with as little damage to the function of hearing as possible.

The factors which one must consider, in determining which type of operation should be applied in any given case, are the age of the patient, the grade of hearing loss before operation, the need for hearing in the patient's occupation, the presence of deafness due to any cause in the second ear, the presence of a chronic suppurative otitis in the other ear with a determination as to which ear is most diseased, and finally the presence of probable or actual complications of the aural suppuration.

In general, children with good hearing may be treated by a well-done "simple" type of mastoidectomy in which one widely opens the mastoid antrum and all mastoid cells, removes all cholesteatoma, opens the tympanic attic by taking down the superior bony canal wall, taking down only enough of the posterior bony canal wall to enable one to do this, without entering the middle ear or cutting any sort of membranous canal flap (Fig. 3). One must endeavor to cause the aditus and attic to be sealed from the tympanum by scar tissue so that squamous epithelium can never again grow into the mastoid antrum and attic to reproduce the cholesteatoma. This is done by packing gauze firmly into the aditus and attic through the posterior mastoid wound, and replacing it for a long enough time to make these spaces fill up completely with healthy granulation tissue. This often entails numerous and rather painful dressings over a period of weeks; this fact with the possibility that the cholesteatoma may not have been fully removed, constitute the disadvantages of the "simple" type of mastoidectomy for chronic suppuration. The great

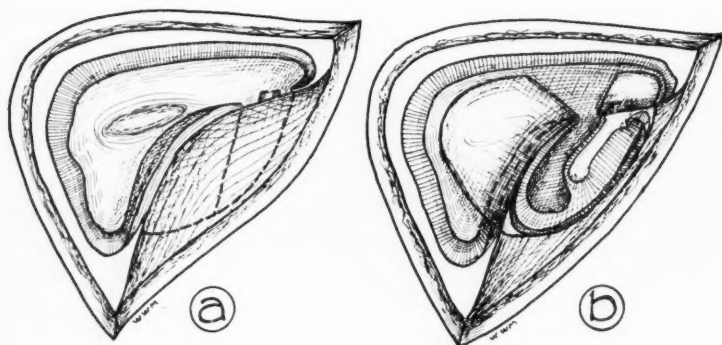


Fig. 6.—A second type of flap from the membranous canal.

a. An expanded type of modified radical mastoidectomy has been performed by the removal of the head of the malleus and the incus. The posterior and superior bony canal walls have been lowered to the level of the annulus tympanicus without traumatizing the membranous canal.

b. After cutting the type of circular flap shown in Fig. 4, it is bisected into a smaller anterior and a larger posterior leaf, by a straight scissor cut from its free margin through to the upper part of the perforation itself. The anterior leaf is folded upward and forward into the anterior attic, while the posterior leaf is folded upward and backward over the facial ridge and into the mastoid antrum. Full control of the healing process is assured since the remaining opening from the attic into the tympanum at the top of the perforation is fully visible and accessible until complete epithelization occurs.

advantage of the operation is the absence of any further loss of hearing because of operation, since the middle ear has not been damaged in the least. It is an operation which is only seldom used today, and which is being replaced by the modified radical operation, for the reason that the latter offers greater certainty of cure with very little added disturbance of hearing.

In adolescents and young adults, with only moderate loss of hearing, and especially those who have a bilateral chronic purulent otitis with more severe changes and worse hearing in the second ear, one of the several forms of modified radical mastoidectomy is usually indicated. This type of operation is characterized by the wide opening of the mastoid antrum and the tympanic attic with complete removal of all cholesteatoma; the removal of the bony posterior and superior canal walls down to the level of the annulus tympanicus

without otherwise disturbing the drum, with or without the removal of the head of the malleus to facilitate removal of cholesteatoma from the attic, and with or without removal of the incus if it is carious or surrounded by cholesteatomatous material; and the permanent drainage of the mastoid antrum and attic into the external auditory canal by throwing these spaces into one cavity through the cutting of a flap or flaps from the membranous external canal (Fig 4a); healing occurs by complete epithelization of all the cavities with a thin layer of squamous epithelium which grows into the cavities from the flaps and from skin grafts placed within them. The middle ear is not invaded except that exuberant granulation tissue may be removed from it through the perforation with delicate forceps. Because of this minimal attack on the tympanum, very slight loss of hearing should result from the operation. This is important in younger patients who must have the best possible hearing for their work; the modified operation should always be done on the better ear, when the other will require the full radical operation because of more advanced disease and greater loss of hearing.

In older patients whose work does not demand the best possible hearing, or in those whose hearing is already seriously impaired by disease, and in those with very large cholesteatomas with extensive bone destruction, the full radical mastoidectomy is indicated. Patients of any age and degree of loss of hearing with threatened or actual complications must have the full radical operation in order to deal best not only with the disease in the middle ear and mastoid antrum, but with the complication itself; this is an absolute indication for the radical operation. The great advantage of the full radical operation is the wide exposure gained, with the corresponding certainty of the removal of all cholesteatoma and disease, and a sure method of preventing its re-formation; the great disadvantage is the loss of hearing which usually follows the destruction of most of the structures of the tympanum, and the scar tissue formation on the promontory and about the labyrinthine windows in the healing process.

Finally, let us consider a few points in the technic of the several operations which have proved useful to the author. First let us note that many of these cases may be operated upon under local anesthesia if one uses 2 per cent procaine or 1:1000 nupercaine solution for injection about the mastoid process and into the external canal, and 10 per cent cocaine in the tympanum; the use of preliminary medication with sodium pentothal, and hyoscine and morphine is of very great help. This method is surprisingly efficient in many

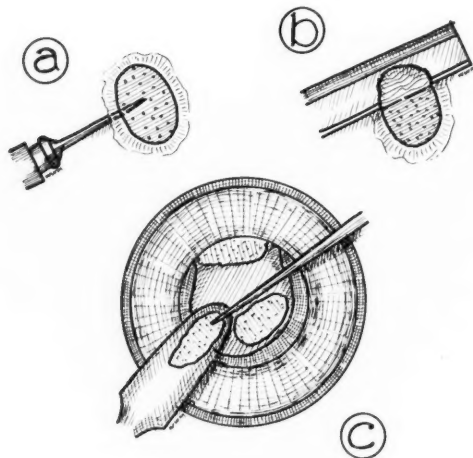


Fig. 7.—The technic of a simple method of multiple secondary epithelial skin grafting of the modified or complete radical mastoidectomy cavity.

a. Local anesthetic solution is injected into the thickness of the skin of the upper arm or thigh on the same side as the ear to be skin grafted, to create heavy wheals the size of a large fingernail.

b. The thinnest possible layer of epithelium is shaved off the top of the skin wheal with a razor blade.

c. The graft is placed on a small flexible spatula, passed into the cavity, slid from the spatula onto the granulations with one or two skin hooks. One such graft is placed over the open end of the auditory tube, one in the anterior attic, one over the facial ridge, and one or two in the mastoid antrum. If they are very thin they will adhere by the serum covering the surface of the granulation tissue so that no packing is necessary. At least four out of five "takes" is the rule. The process may be repeated later if some small area does not quickly epithelialize.

cases, especially for the performance of a modified radical operation. Local rather than general anesthesia is positively indicated in patients with diabetes, advanced nephritis, and suspected or proved intracranial complications, since all general anesthetics have a bad influence on the brain. The use of local anesthesia of course imposes on the operator a need for speed within reason and good technic.

The use of the Hudson bone burr for removing the mastoid cortex and for creating most of the mastoid portion of the radical

cavity is a method that is easy, speedy and safe in careful hands; it shortens the entire approach to the mastoid antrum even through solid cortex to two or three minutes and will not harm the dura, lateral sinus, or the membranous posterior canal wall unless it is grossly abused. Since the gouge and mallet are absolutely contraindicated in the presence of a brain abscess or meningitis because they traumatize the brain by concussion, the use of the bone burr is essential in such cases. The employment of a motor-driven bone burr in taking down the posterior and superior bony canal wall is quite safe with a little skill and practice in its use; the last layer of bone must be removed with curette or rongeur to be sure that it will not later necrose because of devitalization by the heat of the rapidly revolving burr.

The performance of and the results obtained with the modified radical operation have lately been considerably bettered by the use of a new type membranous flap cut from the posterior and superior canal. Its outer limit is made by an incision in the concha just missing the margin of the conchal cartilage and thus avoiding the danger of a perichondritis; the incision also slightly enlarges the meatus for postoperative care (Fig. 5). When the bone work has been done leaving the membranous canal wall intact, a circular flap is cut as is done in labyrinthine fenestration, with its base at the drum margin; it is folded back into the mastoid antrum and up into the attic, and gently packed until adherent (Fig. 4b). It serves to seal off the attic and mastoid antrum from the tympanum. When there is extensive disease and a large perforation of the drum into the aditus and attic, this circular flap may be split with a scissors through its length directly into the upper part of the drum perforation, to create an upper and lower leaf; the former is folded upward and forward to line the anterior part of the attic, and the latter folded backward over the facial ridge (Fig. 6a and b). Epithelium usually spreads rapidly from the margins of these flaps and healing has been unusually prompt and smooth. Another aid to quick epithelization of the cavity is the use of the matrix of the cholesteatoma itself, on the inner wall of the antrum and attic, leaving it undisturbed by the operative procedure, after cleaning away all desquamation from its surface; it serves as a focus for epithelial growth, which is often very rapid indeed.

Early epithelization of the inner wall of the tympanum after the full radical operation has been done serves to cut down the thickness of the scar tissue in this region, which probably accounts for most of the loss of hearing following the radical procedure. This

is best secured by skin grafting, and the preference of the author is for multiple, quite small, very thin epithelial grafts inserted on the tenth to fourteenth day after operation through the meatus, on the fresh and healthy granulation tissue which will have covered the bare bone (Fig. 7a, b, and c). A very high percentage of takes with quick and complete epithelization is the rule, and the procedure is very simple and easy. Done later, when there is exuberant and infected granulation tissue, one has many less takes and there is likely to be thick subepithelial scar tissue to diminish the hearing. It has been the experience of the author that primary skin grafting, done immediately at the conclusion of the radical procedure, will give a very small percentage of takes and is not an easy technic for the average aural surgeon.

Two other small points in technic may be mentioned in closing. Exact work in the tympanum and attic requires really brilliant illumination, for which one of the newer electric forehead lamps is of great help. Further, exact work is greatly aided by the use of magnification with the bright light; a six-inch hand magnifying glass, sterilized in alcohol, is of tremendous aid in the removal of cholesteatoma from the attic, and of the mucosa, etc., about the eustachian tube mouth and the labyrinthine windows, and gives a nice feeling of certainty that all disease has been removed without damage to such vital structures as the facial nerve, the stapes, or the round window.

SUMMARY

1. Chronic purulent otitis media is a relatively common disease, often neglected because of a failure of appreciation of the potential danger to the patient of its most common form.
2. The danger is that superimposed acute infection may gain quick access to the meninges, brain, lateral venous sinus, labyrinth or facial nerve through preformed pathways created by bone destruction consequent on the long-continued pressure of the cholesteatoma associated with marginal perforations of the drum.
3. An accurate diagnosis of the type of condition present and of the presence of cholesteatoma in a few simple steps is possible in the vast majority of cases.
4. Removal of the danger of the condition and cure of the suppuration is best attained by surgical means; all other forms of treatment of the dangerous type of the disease are purely palliative because none of them can fully remove the cholesteatoma, nor can they prevent its re-formation even if removed.

5. The surgical attack must completely remove the diseased tissue and the cholesteatoma, create conditions which will forever prevent its re-formation, and all this with minimal interference with the function of hearing.

6. In most cases this can be achieved by a well-done modified radical mastoidectomy, especially if newer technics and refinements are employed.

7. In other cases the full radical mastoidectomy will be required for certain cure. Here with good postoperative care and early skin grafting, the increase in the loss of hearing may be minimized despite the almost complete destruction of the tympanic cavity which the operation entails.

39 EAST FIFTIETH STREET.

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II

PLASMOCYTOMA OF THE TONSIL

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CHICAGO

Plasmocytoma is a term used indiscriminately for plasma cell accumulations, inflammatory as well as neoplastic in nature and benign as well as malignant in character. According to Ewing¹ plasmocytomas are usually benign tumors. Claiborn and Ferris² stated that most of the malignant cases are, in all probability manifestations of multiple myeloma. Accumulations of plasma cells caused by chronic inflammatory conditions are better known by Borri's³ term "granuloma plasma cellulare." From these observations it is suggested that the term "plasmocytoma" should be restricted to benign plasma cell neoplasms.

Approximately 50 cases in the domain of the rhinolaryngologist diagnosed as plasmocytomas have been found in the literature. However, it is a question whether several of these, because of their malignant characteristic on the one hand or inflammatory features on the other hand, should be designated as plasmocytomas. Because of the relative infrequency and obscurity of this lesion, a case is presented which the writer has had opportunity to study in detail.

LITERATURE

According to the literature, plasma cell tumors occur more frequently in men. The age incidence ranges from 20 to 70 years, although the tumor seems to occur most often in individuals over 40 years of age. The symptoms depend upon the location of the lesion. Because a majority of these neoplasms develop in the nose, nasal obstruction and epistaxis are frequent symptoms. Tumor sites, besides the nose, are the pharynx, accessory nasal sinuses, and the larynx.

For the literature on plasmocytoma of the upper respiratory regions, the reader is referred to the tabulations of Claiborn and Ferris,² who reviewed 14 cases; Blumenfeld,⁴ who listed 7 additional cases, and Mattick and Thibaudeau,⁵ who presented 6 cases not previously reviewed. Additional cases have been reported by Vlasto,⁶ Broste,⁷ Jackson, Parker, and Bethea,⁸ New and Harper,⁹ Campbell and New-

ton,¹⁰ Sammartino,¹¹ Laub,¹² Milian,¹³ and Brunetti.¹⁴ According to Brunetti,¹⁴ Ringertz has contributed 14 additional cases.

CASE REPORT

The patient, a 40-year-old male, complained only of a slight difficulty in swallowing noticed over a two-month period. Examination disclosed a polypoid structure, measuring 6 mm. in length, projecting from the right tonsil. Its external appearance was indistinguishable from tonsillar tissue. The lesion was excised.

The gross specimen consisted of a tonsil measuring 3 by 2 by 1.5 cm. One surface was convex in contour, pale tannish pink, glistening and with multiple shallow indentations. Another appeared flatter and slightly ragged. From the vicinity of one pole extended a soft, somewhat fleshy, tongue-like projection.

Pendant from the midportion of the convex surface was a firm, polypoid structure, measuring 1 by 2 cm. in greatest dimensions. Its external surface was grayish white and its gross architecture resembled that of the tonsil proper. On section the polypoid structure was found to be homogeneous, grey-white, and glistening; the tonsil, greyish pink and fibrillar or adenoidal in appearance.

Upon histologic examination of the pendant polypoid structure, cellular elements were found in some sections to be diffusely distributed. In other fields they were arranged in strands, with intervening eosinophilic, homogeneous, hyalin-like material.

The cells were more or less uniform, round or oval, with eccentrically located nuclei. The cytoplasm was a deep purple, either finely granular or homogeneous. The chromatin, deeply basophilic, was distributed along the border of the nucleus and at its center, presenting a cartwheel appearance (Giemsa and hematoxylin-eosin stains). The pyronin green (Unna-Pappenheim) stain revealed red nuclei and green cytoplasm. Perinuclear haloes were frequently observed and there were occasional cells with two or three nuclei. However, neither Dorothy Reed nor Langhans giant cells were identified.

Among these plasma cells there were a few small, well-demarcated groups of oval, pale staining cells. These had large and vacuolated nuclei, each containing a prominent nucleolus. The cytoplasm of these cells were slightly eosinophilic and poorly defined. Throughout the sections of the polypoid structure was noted a rather slight infiltration of polymorphonuclear leucocytes and lymphocytes. The stroma contained a considerable number of small sized blood vessels. Occasional minute hemorrhages and endothelial leucocytes were seen, their cytoplasm containing a moderate number of brownish yellow pigment granules.

Foot's reticulum stain showed an extensive, delicate, reticular network throughout the polypoid structure. Gram-Weigert, Ziehl-Neelsen, and Kanzler's spirochete stains gave negative results.

The superficial portion of the polypoid structure consisted of a layer of squamous cells. Between these squamous cells and the adjacent lymphadenoid structures of the tonsil were discernible infiltrating foci, more or less circumscribed, of plasma cells. These appeared to be a direct extension of the cells which constituted the polypoid structure.

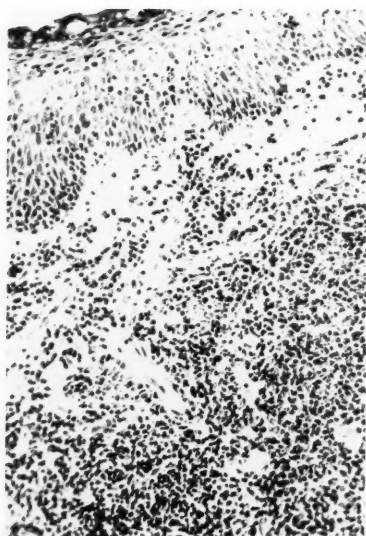


Fig. 1.

Sections taken from the tonsil proper showed large, irregular areas composed entirely of polymorphonuclear leucocytes. In addition there were noted large follicles, well separated from the pulp. The pulp itself contained an apparently normal quantity of lymphocytes and endothelial leucocytes, as well as very few plasma cells.

DISCUSSION

The most striking microscopic finding was the marked proliferation of plasma cells. The morphologic appearance of these cells, with their cartwheel nuclei as well as their reaction to the methyl-green pyronin stain, was characteristic. Some of them were relatively large and had two or three of the "cartwheel" nuclei, but there was no morphologic difference. The stroma consisted of either a fine reticulum or of coarse hyalinized connective tissue. Very occasional lymphocytes, polymorphonuclear leucocytes, and groups of reticulum cells were sparsely scattered through the sections of the polypoid structure.

Offhand, three possible diagnoses presented themselves: atypical Hodgkin's granuloma, myeloma of the plasma cell variety or the

so-called "granuloma plasma cellulare." The possibility of a leucemic infiltration was easily eliminated by the presence of normal white blood cell and differential counts, as well as by the absence of histologic support. Furthermore, leucemic infiltrations consisting mainly of plasma cells in the absence of bone lesion are extremely unusual.

Since there are instances on record of localized Hodgkin's disease, the fact that only the tonsil was involved would not in itself exclude a Hodgkin's lesion. Moreover, several cases of atypical Hodgkin's disease are reported in which one type of cell predominated, while the other cellular components of the Hodgkin's granuloma were present in lesser numbers. Nevertheless, it seems improbable that the lesion in question, with its almost complete preponderance of plasma cells, is sufficiently pleomorphic to represent even an atypical form of Hodgkin's disease.

A diagnosis of multiple myeloma is equally unlikely. According to Geschickter and Copeland,¹⁵ there were reported until 1931 only five cases of myeloma appearing in a single focus and none of these was verified by autopsy, although some thorough roentgen-ray studies were made. There is a histologic difference between the so-called "plasma cells" of the myeloma and the plasma cells observed in the present lesion. Geschickter and Copeland¹⁵ state that myelomatous "plasma cells" do not react to the specific plasma cell stain (Unna-Pappenheim) and that a perinuclear halo is rare. They further note that myelomas almost always reveal a lymphocyte-like cell with little cytoplasm and with a large globoid nucleus containing compact chromatin. Mitotic figures are frequent in these tumors. There are generally many vessels in myelomas and hemorrhages are frequent. The present lesion disclosed typical plasma cells and only infrequent lymphocytes and polymorphonuclear leucocytes. Mitotic figures were extremely rare. Although blood vessels occurred throughout the lesion, they were not thin-walled and hemorrhages were not obvious. Therefore this structure, although morphologically similar, differs essentially and significantly from the myeloma.

In this connection it may be mentioned that investigators claimed that plasma cell tumors confined to the mucous membrane are nevertheless true myelomas. Such claims were based upon the assumption that bony involvement would have been disclosed had there been necropsy or roentgen-ray study. However, Claiborn and Ferris² opposed this idea, presenting twelve reported cases of plasma cell tumors of the nasal and nasopharyngeal mucosa, as well as two which they themselves observed. From their description none of

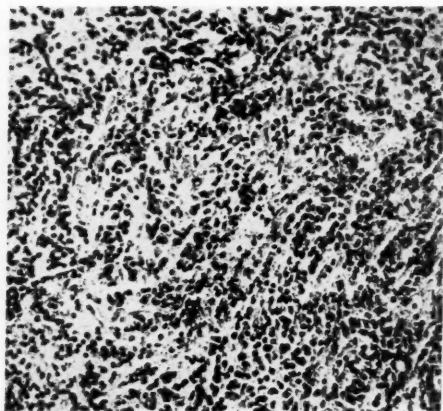


Fig. 2.

these 14 cases appear to be true plasma cell myelomas. One of the authors' two cases was diagnosed as a plasma cell granuloma. In the other case plasma cell myeloma was first entertained as a possible diagnosis but was discarded because of the benign characteristics of the lesion. The final diagnosis was "plasmocytoma."

We must therefore consider, in the present case, the possibility of a "plasmocytoma," in addition to that of a "granuloma plasma cellulare," which was the last of our three originally suggested diagnoses.

Borri²³ considered the granuloma plasma cellulare as a defense reaction, characterized by the production of plasma cells, which occurs in prolonged infections such as tuberculosis and syphilis.

Grossly, this lesion assumed the appearance of a tumor, well-differentiated though not encapsulated. Microscopically, a new formation of typical plasma cells was the conspicuous feature. No micro-organisms were identified. There was no clinical or histologic indication of syphilis or tuberculosis. The lesion was in no way similar grossly or microscopically to any of the various examples of chronic tonsillar inflammation which are described in the literature. For all these reasons, we can, therefore, conclude that this lesion was a tumor, rather than a granuloma. Further, we can assume that it

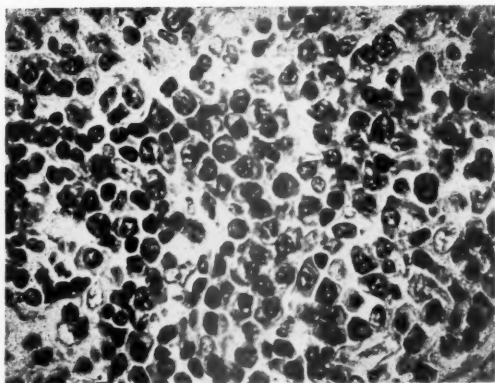


Fig. 3.

was a benign tumor because of its histologic differences from the plasma cell myeloma, notably the scarcity of mitotic figures.

Following the nomenclature of Claiborn and Ferris,² this lesion should be diagnosed "plasmocytoma."

The patient received surgical treatment. There was no evidence of recurrence, nor were there any other manifestations of tumor recognized after three years.

SUMMARY

An instance of plasmocytoma of the upper respiratory passages in a 40-year-old male is reported. The lesion did not recur after three years following surgical removal. The differential diagnosis between Hodgkin's disease, plasma cell myeloma, granuloma plasma cellulare, and plasmocytoma is discussed.

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III

NASOPHARYNGEAL FIBROMA*

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The recent reports in the literature concerning nasopharyngeal fibromas by Friedberg,¹⁰ Figi,⁹ Som and Neffson,³⁰ and Hughes¹⁵ contain all of the present-day knowledge of the subject. A repetition of a discussion of this entity seems to be even more superfluous inasmuch as some of the recent papers deal with a considerable number of these cases. Sébilleau²⁸ reports 60 cases; Shaheen,²⁹ 58 cases; and Figi,⁹ 63. Considering such numbers there does not seem to be any good reason to report but 4 cases. However, the situation is different if one bears in mind the fact that the 63 cases reported by Figi⁹ were collected over a thirty-year period at the Mayo Clinic and those of Sébilleau²⁸ and Shaheen²⁹ are not all true nasopharyngeal fibromas. Among the cases of Sébilleau²⁸ are also included retronasal polyps which are entirely different pathologic entities from the types of tumors under discussion. Even more conspicuous are the cases reported by Shaheen,²⁹ who found nasopharyngeal fibromas in boys of 2 to 7 years of age and in men between the ages of 48 and 70 years. Furthermore, Shaheen²⁹ emphasizes a carcinomatous and sarcomatous degeneration of these tumors, a finding which is extremely rare. I am in complete agreement with Figi,⁹ who doubts that Shaheen²⁹ was solely concerned with nasopharyngeal fibromas. Even considering these justifiable doubts, only four cases are described. In Cases 2, 3, and 4 another form of treatment was applied than in Case 1, and in Cases 2, 3, and 4 exhaustive microscopic study of the extirpated tumors was carried out.

REPORT OF CASES

CASE 1.—J. B., an 18-year-old white male. For the past year the left side of his nose had been blocked and there had been occasional purulent discharge from the left nostril. He had had two operations performed on his nose, but was unable to describe the type of operation. He complained of intense headaches and for the eight days before examination had noted double visions. On admission to the ear, nose, and throat department of the Policlinic of Vienna on July 24, 1935, the following findings were noted: There were remnants of a chronic otitis media on the

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right ear and a middle ear catarrh on the left. The nasal septum was markedly deviated to the right and the left half of the nose was filled by a smooth tumor of grayish red color. The tumor extended into the epipharynx, filling its entire left half and the greater part of the right half. Both choanae were obliterated by the mass. There was a definite protrusion of the left eyeball and a paresis of the left abducens nerve. X-ray examination revealed the cervical vertebra to be normal. The sphenoid sinus appeared hazy. The superior wall of the sphenoid (floor of the sella) was definitely thinned and even partially obliterated; the posterior boundaries of the sinus were indistinct as was the dorsum sellae. The eyegrounds were normal.

A biopsy was taken on July 25. The microscopic examination revealed a chronically inflamed mucous membrane which evidenced giant cells (foreign-body reaction) around a silk thread, apparently the remnant of a former operation.

On July 30, under local analgesia, a Denker operation was done on the left maxillary sinus. The mucous membrane of the sinus was pale, edematous and there was a polyp present as large as a cherry, filled with mucus. The posterior part of the mesial wall of the sinus was destroyed by the tumor which was adherent at this point to the mucous membrane. The mucous membrane of the sinus was intact at this point. The mesial wall of the sinus as well as the inferior turbinate were removed, the latter being adherent to the tumor. The tumor was readily separated by means of finger dissection from the superior boundary of the choana, but it was firmly attached to the inferior boundary and to the pterygoid process. Large pieces of tumor were removed so that both choanae became patent. This part of the operation was not difficult inasmuch as the tumor consisted of firm connective tissue and did not contain many blood vessels. However, a severe arterial bleeding, probably originating from the ascending pharyngeal artery, occurred when an attempt was made to remove the tumor from the inferior margin of the choana and from the pterygoid process on either side. The operative procedure was culminated by inserting a tampon into the epipharynx. This posterior pack was removed on July 31 without any further bleeding. However, a severe hemorrhage occurred after removing the nasal pack on August 5 and a new tampon had to be inserted.

On Aug. 6 the blood contained 4,800,000 erythrocytes, 11,100 leucocytes, (56 per cent polymorphonuclear cells, 3 per cent juvenile forms, 29 per cent lymphocytes, 9 per cent monocytes, 2 per cent eosinophiles, 0.5 per cent metamyelocytes and 0.5 per cent forms of Tuerck). The color index was 0.9 and the hemoglobin 90 per cent.

On Aug. 13 the maxillary sinus was reopened under general anesthesia. The remnant of the tumor was removed from the inferior boundary of the choana and a curettage of the epipharynx was performed. There was only slight bleeding. On Aug. 22 the patient was dismissed from the hospital and further X-ray treatments were administered as an ambulatory procedure. The epipharynx was given X-ray from a right and a left field, six treatments of 250 r. being applied to each side, making a total of 3000 r.

One month later the headaches and the protrusion of the eye disappeared, but the patient still complained of double vision and was again having difficulty in breathing. Examination on Nov. 27, 1935, again revealed a tumor occupying the entire epipharynx and growing through the left choana into the nose. Consequently, the maxillary sinus was again opened. There was a firm scar in the region of the aperture piriformis, drawing the cheek into the sinus. The scar was excised and the tumor could be seen covered by a normal mucous membrane. The tumor was

destroyed by electrocoagulation, but a severe hemorrhage prevented further eradication of the entire tumor and tampons had to be applied. On Dec. 4 electrocoagulation was again attempted and again was interrupted by a severe arterial hemorrhage. On January 3, 1936, after resection of the nasal septum, the tumor was coagulated through the nose. However, no stress was laid upon a radical removal of the tumor inasmuch as X-ray examination was suspicious of an erosion of the base of the skull and the age of the patient made a spontaneous regression of the tumor possible in the near future. In the middle of 1937 the patient felt well. There was no double vision, no protrusion of the eye, no shortness of breath, but there were some small remnants of tumor in the epipharynx.

CASE 2.—W. T., a 14-year-old white male, was referred to me through Dr. H. L. Casebeer from Butte, Mont. The boy had been suffering from difficulty in breathing through the nose for the past four or five years. There were never any headaches or hemorrhages from the nose or the mouth. The physical and mental development was entirely normal. The patient had had two previous operations for adenoids, the first when he was 4 years old and the second one and one-half years ago. Following both operations an uneventful recovery was experienced. In January, 1940, two biopsies were taken from the tumor and each procedure was accompanied by a profuse hemorrhage and by an acceleration of the tumor growth. Examination on June 20, 1940, revealed a strong, very well developed boy with a definite rhinolalia clausa. The ear and the throat were normal. The boy could not breathe through his nose inasmuch as the entire epipharynx was occupied by a pinkish red, firm tumor covered by a normal mucous membrane. The tumor extended into the mesopharynx, but apparently not into the nose. The tumor was immobile. X-ray examination revealed a haziness of the left maxillary sinus.

On June 25, 1940, under intratracheal anesthesia, the left maxillary sinus was opened according to the technique of Denker. There was no pus and the mucous membrane was normal. However, the posterior ethmoidal area was pushed markedly into the maxillary sinus. The mesial wall of the maxillary sinus was removed and the tumor was observed extending toward the posterior ethmoid, being attached to the posterior end of the inferior turbinate. The succeeding part of the operation was accompanied by a severe hemorrhage and by a general epileptic attack lasting about ten minutes. The tumor together with the posterior end of the inferior turbinate was removed by finger dissection from the inferior surface of the sphenoid and from the posterior ethmoid. Then the inferior portion of the tumor, which was firmly attached to the nasal surface of the soft palate, was grasped with a rongeur and slowly extirpated through the nose. A large tampon was inserted into the epipharynx; the maxillary sinus was packed with vaseline gauze. The wound in the mouth was closed with interrupted sutures. The removed tumor mass weighed 10 gm. After the operation an infusion of physiologic salt solution was administered. The patient had slight rises in temperature for a few days, but there was no further hemorrhage. On June 30 the tampon was removed from the epipharynx without bleeding. On July 5 the gauze was removed from the maxillary sinus, also without bleeding. The patient was dismissed from the hospital in good general condition. However, there was an abundant growth of granulations from the nasal surface of the soft palate, from the ethmoid, and from the inferior surface of the sphenoid. These granulations filled a part of the left half of the epipharynx. For this reason the patient was treated postoperatively by Dr. Casebeer with X-rays. He reported a definite improvement of the patient on Jan. 14, 1941.

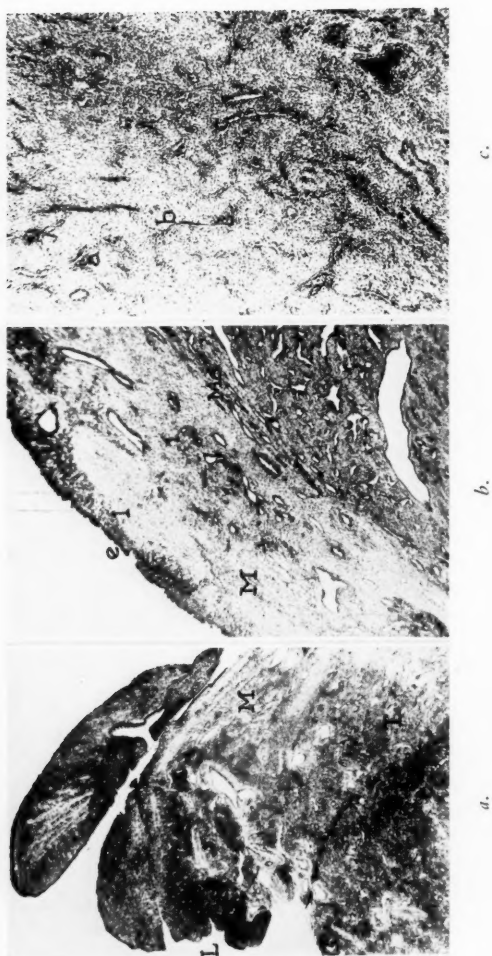


Fig. 1. Case 2.—M. Mucous membrane. L. Subepithelial lymphatic tissue. c. Transitional epithelium. Ma. Margin between tumor and mucous membrane. T. Tumor. L. Lymphatic tissue of the mucous membrane of the lateral wall of the nasopharynx. a. Center of a tumor nodule with scanty cells. b. Periphery of a nodule with an increasing number of cells and newly formed blood vessels. c. Boundary of a nodule with numerous cells.

There was no recurrence of the tumor noted and the patient suffered only from an occasional copious, mucous discharge from the nose. In the succeeding months of observation Dr. Casebeer noticed a marked tendency to nasal bleeding on the operated side. Toward the end of February, 1941, a pedicle growth was observed arising from the middle meatus. On May 26 this new formation was about 8 mm. in diameter and appeared firm and red and was considered by Dr. Casebeer to be another fibroma. In July, 1941, the tumor had grown to such a size as to fill the entire epipharynx. The patient was treated with radium and electrocoagulation inasmuch as the parents decided against another operation.

The tumor was covered partly by mucous membrane. As far as an epithelium could be seen, it was most frequently a high columnar in character without cilia, but occasionally with a basement membrane. There was a different relation between the tumor and the mucous membrane in various areas. At some places the tumor reached the epithelium so that there was no mucous membrane remaining. In other areas the mucous membrane was definitely edematous, showed a well-developed lymphatic tissue, but did not contain any glands. In such places there were no distinct margins between tumor and mucous membrane. In other areas the mucous membrane was compressed and contained atrophied glands (Fig. 1B). In these sites there were distinct margins between tumor and mucous membrane. Finally, in some areas the tumor was covered by a mucous membrane containing a thick layer of lymphatic tissue, having deep crypts but no follicles (Fig. 1A). In these places the margins between tumor and mucous membrane were indistinct. These latter findings indicated that we were concerned with mucous membrane of the nasopharynx in these places and not with mucous membrane of the nose.

The tumor consisted of nodules which could be seen even macroscopically inasmuch as they contained a light center and a boundary line, darkly stained with hematoxylin because of the enormous number of nuclei (Fig. 1C). There were a great amount of collagenous fibers which revealed so many nuclei in some areas that one had the impression of a sarcoma, while on other places the number of nuclei was smaller. There were many blood vessels which here and there seemed to form a network resembling a corpus cavernosum. There were no elastic fibers within the tumor tissue proper. In sections stained after the Pap technic, the tumor presented a fine network of argentophile fibers which extended between the blood vessels.

The tumor nodules were surrounded by a boundary line containing an enormous number of connective tissue cells, lymphocytes, and newly formed capillaries. This boundary line was due to the growth of the tumor node which may have extended to the epithelium of the mucous membrane. Where this boundary line was absent there was a distinct demarcation between tumor and mucous membrane. In such areas the mucous membrane showed definite fibrosis, contained some lymphocytes, but only atrophic glands.

The blood vessels of the tumor presented various structures. The greater part consisted only of a delicate endothelium supported by connective tissue. The lumina of these vessels were usually empty. The surrounding connective tissue frequently presented edematous areas infiltrated by cells resembling lymphocytes.

In addition to these vessels there were large veins (Fig. 2), the walls of which contained elastic fibers. Furthermore, small arteries with the three coats and an elastica interna (Fig. 2B) were also found. The arteries were usually surrounded by a mantle of firm connective tissue which contained but few nuclei, and were



Fig. 2. Case 2.—A. Arteriole. V. Vein. *a.* Capillary of the tumor pouring into the vein.

occasionally accompanied by nerves (Fig. 9). These nerves as well as the arteries were not parts of the tumor itself, but rather belonged to the mucous membrane. As a matter of fact, on serial sections one frequently can observe the stages of the process whereby the arteries of the mucous membrane are being engulfed by the tumor and thereby becoming embedded.

Finally, there were chips of bone within the tumor itself which were surrounded by periosteum (Fig. 9). In some places the bone chips revealed an apposition by osteoblasts while in others there was destruction by osteoclasts. This finding cannot be explained by an ossification of the connective tissue of the tumor inasmuch as the bone chips were surrounded by a periosteum which contained many nuclei and nowhere did the tumor present calcium deposits. Examination of serial sections rather presented evidence that the thin bony plates of the lateral wall of the nose had been crumbled by the pressure of the tumor and the bony fragments had been engulfed by the tumor. Thus, it was possible to observe a bony chip in the midst of the tumor, if only a single section was examined.

Together with the tumor, cells of the ethmoid, not yet invaded by the tumor, were removed. Serial sections were prepared and although the specimen was greatly distorted by the operation, microscopic examination revealed the following: The bone was normal and there was a normal fibrous marrow between the bony plates. The marrow contained greatly distended capillaries. The mucous membrane was compressed on some places and edematous on others. Within the edematous mucous membrane there were foci, particularly conspicuous because of a marked increase of connective tissue. This connective tissue did not contain as many nuclei as did the similar component of the tumor. However, it did contain the same blood

vessels, the walls of which consisted only of a delicate endothelium such as found in the tumor, and were surrounded by dense connective tissue. On such places the epithelium of the mucous membrane was absent, perhaps the result of an artefact, and the glands were definitely atrophic, scanty, or entirely lacking. Occasionally, connective tissue of the altered mucous membrane had invaded the bone and enclosed bony fragments so that single sections showed bone chips embedded in this altered mucous membrane. The bone chips were surrounded by a periosteum which contained many nuclei and they frequently presented Howship lacunae corresponding to the findings in the tumor itself.

CASE 3.—G. R., a 16-year-old white male, in March, 1939, had had influenza which was followed by a blockage of the right side of his nose. One month later he suffered from severe nosebleeds which occurred two to three times a week in the following eight to nine months. The blockage of the nose increased. In December, 1939, and January, 1940, three operations were performed on his nose without success. After the last operation he noticed a gradual, painless swelling of the right cheek. He had the feeling of "pins and needles" sticking into the skin of the right cheek. He was treated with radium (480 mg. hours) and X-ray therapy in May, 1940. However, the nosebleeds increased. In August, 1940, a portion of the tumor was spontaneously extruded through the right nostril followed by a general improvement without, however, furnishing a better airway through the nose. The left nostril was also occasionally not patent. In December, 1940, in another institution the right external carotid artery was ligated and a biopsy was taken which was followed by a severe hemorrhage. After this operation he noticed a diminution of hearing on the right ear and lost 10 pounds in weight. Two weeks before admission he suffered from intense pains in the right forehead, orbit, and maxilla lasting for one week and disappearing without treatment. For the past few days he had noted a rise of temperature in the evenings.

On admission, Jan. 22, 1941, he appeared very pale and spoke with a definite rhinolalia clausa. The right nostril was markedly dilated and filled with a grayish tumor mass (Fig. 3). The tumor was not adherent to the ala nasi. The nasal septum was pushed to the left and completely occluded the left nostril. The nasal mucous membrane on the left side was red and there was a purulent discharge present. The right cheek was swollen and the skin over the involved area was red but not tender. Behind the soft palate, there was a dark, firm, smooth tumor which bulged the soft palate forward into the mouth. The left occipital node as well as the cervical glands were swollen and firm, but not tender. Examination of the eyes did not reveal any pathology. A blood transfusion was given. On Jan. 23, the laboratory findings revealed: Hg., 70 per cent; erythrocytes, 4,050,000; leucocytes, 12,000 (lymphocytes, 20 per cent; monocytes, 5 per cent; polymorphonuclear cells, 74 per cent; eosinophiles, 1 per cent). On Jan. 25, X-ray examination revealed cloudiness of all sinuses on the right side. After several blood transfusions the hemoglobin increased to 80 per cent and there were 4,350,000 erythrocytes on Feb. 6, 1941.

Under intratracheal anesthesia and a continual drop infusion of physiologic salt solution and blood the patient was operated upon on Feb. 8, 1941. An incision after Oehngren was made which furnished an excellent view. The tumor, consisting of a reddish, firm tissue was at once exposed inasmuch as the anterior wall of the maxillary sinus and the greater part of the apertura piriformis were destroyed. There was only a slight amount of active bleeding. By means of the finger, the tumor was separated from the lateral and upper wall of the maxillary sinus, from

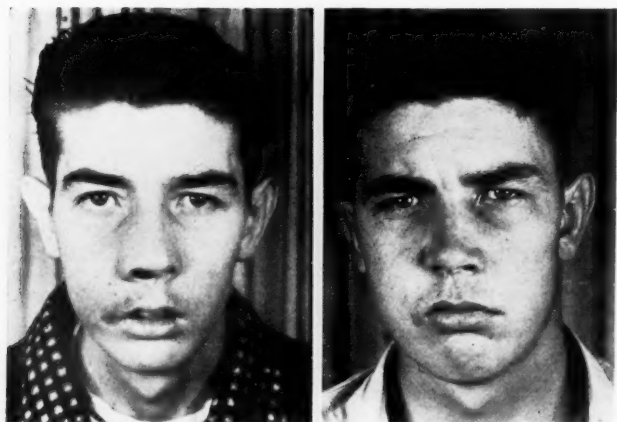
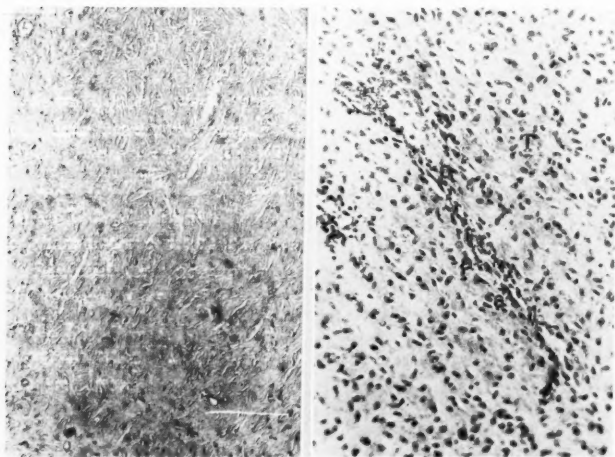


Fig. 3. Case 3.—Patient before the operation and six months after the operation.



A.

B.

Fig. 4. Case 3.—A. Tumor tissue with scanty nuclei and hyalin degeneration. B. Angiolysis within the tumor. T. Tumor tissue with hyalin degeneration. a. Endothelial cells.

the ethmoid, and from the septum. This maneuver was accompanied by a slight amount of bleeding. The attachment of the tumor to the floor of the nose and the floor of the maxillary sinus was much more adherent, but nevertheless, could finally be separated. Toward the epipharynx, the adhesions of the tumor became more adherent. Since the very large tumor barred the entrance into the epipharynx two pieces from the anterior part of the tumor were removed with the electric knife. The cut surfaces were drawn together by means of sutures. It was not difficult then to separate the tumor from the roof of the epipharynx. However, there were firm adhesions between the tumor and the inferior and lateral boundaries of the right choana. These adhesions had to be cut through with scissors. It was then possible to remove the entire tumor together with the posterior end of the right inferior turbinate. In removing the tumor the curved periosteum elevator of Hedblom was of great aid. The tumor weighed 140.5 gm. After removal of the tumor, there was a large cavity present covered with blood coagula. The mesial wall of the cavity was made up by the nasal septum, its inferior wall by the floor of the nose and the maxillary sinus, and its lateral wall by the lateral wall of the maxillary sinus. The mesial wall of the maxillary sinus, the vertical plate of the palatine bone, and the right pterygoid process could not be visualized. The mesial part of the posterior wall of the maxillary sinus was destroyed so that there was a broad communication between the maxillary sinus, epipharynx, and the sphenoid sinus, the anterior wall of which was destroyed by the tumor. The orbit was not involved but the ethmoid sinus was invaded from below by the tumor.

A feeding tube was inserted through the nose and retained in situ for two days and a posterior pack was kept in place for four days. The cavity was drained by way of the nose and the mouth. The skin incision was closed, while the incision of the mucous membrane of the vestibulum oris was allowed to remain open. An uneventful recovery ensued.

A re-examination on Feb. 21 revealed a very copious discharge of mucus into the cavity. The lateral wall of the maxillary sinus was covered by granulations. The mucous membrane of the nasal septum was normal, but there were granulations on its posterior margin. The rostrum of the sphenoid was absent. The ethmoid, the floor of which was missing, was filled with hyperplastic mucous membrane as were the sphenoids, the floor of which was also lacking. The left lateral wall of the pharynx was pushed into the sphenoid. The lateral margin of the right choana was covered by a white necrotic slough. The tumor had originated probably from this site.

By May 22 the general condition of the patient had improved considerably. There was an increase in weight and the patient's color was excellent. He had no complaints at the time. There was a small sublabial fistula remaining on the right side. The external scar was fine and barely visible. The right nasal cavity was still large although smaller than at previous examinations. It was covered by many large yellow crusts. The epipharynx was clear. The septum was markedly deviated to the left, practically closing off the entire side. The margins of the right choana were covered by crusts.

When observed on Aug. 11, 1941, the patient had gained 45 pounds (Fig. 6). He bled once in a while when he removed the crusts from the left nostril. The right nostril was covered with crusts, after removal of which it was seen that the middle and inferior turbinates were not present. The maxillary sinus was opened widely and there was a slight amount of pus near the choana in the region of the



Fig. 5.—Oblique frontal section through the base of the skull of a newborn female infant. The section is situated behind the insertion of the vomer. N. Nasopharynx. M. Mesopharynx. SP. Soft palate. Lp. M. levator veli palatina. a. Pharyngeal hypophysis. g. Glands. FC. Fascia basalis with large blood vessels in the midline. T. Eustachian tube. P. Pterygoid process. Sy. Synchondrosis intersphenoidalis. R. Rostrum. Pe. Periosteum. Po. Periosteum of the orbit. A. Ophthalmic artery. Ap. Ala parva of sphenoid. No. Optic nerve. D. Dura of planum sphenoidale. Sc. Body of sphenoid. c. Extensions of the fascia basalis toward the periorbit.

superior meatus of the nose. There was a large synechia between the septum and the lateral wall of the nose. On the roof of the epipharynx there were granulations which filled the entrance into the open sphenoid. The mucous membrane of the posterior part of the septum on the right side was edematous. There was no recurrence of tumor tissue visible* and the glands of the neck were not swollen.

The tumor consisted mainly of dense connective tissue, the fibers running in all directions. In some places the tissue contained many nuclei, although they were not as numerous as those in Case 2. In other areas there were only scanty nuclei, upon which some sites were lacking entirely, bordering on decay (Fig. 4). There was no distinct margin between these different areas.

Between the connective tissue fibers many blood vessels were found, the walls of which consisted of a delicate endothelium and a network of argentophile fibers. These blood vessels were found particularly in the areas containing many nuclei. The blood vessels were rather large and occasionally accompanied by nerves. Close to the surface of the tumor these vessels frequently contained hyaline thrombi, wherein were located many polymorphonuclear cells. Large veins and small arterioles as seen in Case 2 were not found in Case 3. On one side the tumor was covered by a necrotic epidermis with definite papillae and here the tumor consisted chiefly of capillaries with scanty connective tissue, but many lymphocytes and plasma cells, between them.

Occasionally there was a hyaline degeneration of the connective tissue around the blood vessels. This finding was also observed by Ballo² in his cases. However, as a rule, there were no blood vessels in the hyaline areas or they were found to be in a state of angiolytic (Fig. 4B). In the latter case, there was an amitotic increase of endothelial cells, the cells producing small heaps around the blood vessels. These endothelial cells did not grow only around the blood vessels, they also grew into their lumina, thus obliterating the vessel. This tumor likewise did not show deposits of calcium or bone production. However, there were, in the mucous membrane adjacent to the tumor, arterioles, the walls of which were so thickened that the lumen was almost obliterated. A hyaline degeneration of these walls, as Ballo² observed in his cases, was not found in our case.

The mucous membrane of the left inferior turbinate on the convexity was covered by a columnar epithelium which did not contain goblet cells and which was partially destroyed. The mucous membrane consisted of a thin layer of edematous connective tissue, containing few capillaries and scattered lymphocytes and plasma cells, but no glands. On the concave side, where the turbinate was adherent to the tumor, the mucous membrane was much thicker, was covered by a layer of columnar epithelium, and showed a considerable infiltration of lymphocytes and plasma cells. There were numerous hemorrhages and a definite edema, but here again on this side the glands were absent.

The bone of the turbinate was partly destroyed by osteoclasts which originated from the connective tissue in the marrow spaces or from the periosteum on the convexity of the turbinate. In order to preserve the bony skeleton of the turbinate, the periosteum on the concave side of the turbinate had increased markedly and within it, ramified bone of the osteophytic type had formed, growing together with the remnants of the original bone of the turbinate. The osteophytic bone consisted of a woven bone while the original bony plate consisted of a lamellar

*There was no recurrence in February, 1942.



Fig. 6.—Oblique frontal section through the base of the skull of a female newborn. The section is situated at the level of the choanae. *M.* Mesopharynx. *N.* Nasopharynx. *g.* Glands. *Lp.* *M.* levator veli palatini. *P.* Pterygoid process (which was lost during preparation in *x*). *Fp.* Fossa pterygopalatina. *R.* Rostrum. *FC.* Fascia basalis. *Pe.* Periosteum. *Po.* Periosteum of orbit. *No.* Optic nerve. *D.* Dura of planum sphenoidale. *Sc.* Sphenoid body. *C.* Connection between fascia basalis and periorbit. *V.* Vomer. *Ap.* Ala parva of sphenoid.

type. Furthermore, the osteocytes of the osteophytic bone were by far larger than those of the original bone.

CASE 4.—J. G., 15 years old, white, male, was first seen by Dr. J. A. Weiss in January, 1938, with a history of nasal blockage on the left side and repeated epistaxes of about one and one-half years' duration. When he was 5 years old a tonsillectomy and adenectomy had been performed.

Examination revealed a tumor mass filling the left half of the nasopharynx and the entire left nasal passage to within 1 cm. of the external naris. The left choana was completely occluded and the right partially obstructed. A biopsy was taken and the microscopic examination revealed a typical vascular fibroma of the juvenile type.

Between March 2 and April 20, 1938, he received 80,000 mg. hours of telerradiation to each side of the nasopharynx by means of the 4 gm. radium pack. At the end of this period all of the nasal portion of the tumor had regressed. The apparent attachment was in the pharyngeal vault. By June 29, 1938, the right posterior choana was open although the left was still obstructed. On July 24, 1938, electrocoagulation of the tumor, under intratracheal nitrous oxide, was performed. This procedure was incomplete, due to the severe bleeding, despite previous irradiation. On Aug. 8, 1938, a transantral ligation of the internal maxillary artery was performed. No tumor mass was found in the antrum. The tumor in the epipharynx was partly removed with the snare. Slight postoperative bleeding which followed was readily controlled.

By March 3, 1939, the remaining tumor mass, about 1 by 2 cm. in size, was seen in the upper lateral angle of the nasopharynx. Electrocoagulation was performed via the mouth, using the Yankauer speculum and Haslinger retractor. Bleeding was not excessive. The blood revealed 4,620,000 erythrocytes and 8,000 leucocytes. The hemoglobin was 70 and the Wassermann test was negative. On March 15, 1939, there was a single brisk hemorrhage of about 200 c.c. By March 17 the remaining tumor tissue was coagulated under local analgesia.

On Feb. 9, 1940, the patient returned after eleven months, and a large regrowth of the fibroma, filling the left half of the nasopharynx, was noted. On Feb. 10 an electrocoagulation of the tumor under intravenous pentothal was performed. There was no excessive bleeding, but again not all of tissue was destroyed. A postnasal pack was inserted. There was a febrile postoperative course averaging 101° F. (rectally) for about ten days. By Feb. 14 a Horner's syndrome (constriction of the left pupil and an endophthalmus) was noted probably due to the coagulation trauma of the cervical sympathetics or possibly to deep hemorrhages into the tissues of the neck.

On Feb. 16 a severe nasal hemorrhage occurred. Immediately, two safety sutures were loosely applied to the common carotid artery. When hemorrhage recurred on Feb. 20 these sutures were tied. There was no subsequent bleeding; blood transfusions of 500 c.c. were given on Feb. 20 and 24.

Examination on March 4, 1940, showed a slight amount of tissue high up in the nasopharyngeal vault. The patient was advised to return in two months. However, he returned on Aug. 29, 1940, having had a hemorrhage of a "pint" on Aug. 23. There was a considerable regrowth of the tumor which now was attached to the posterior border of the septum, extending across the midline and partly obstructing the right choana. There were 3,180,000 erythrocytes and the hemoglobin was 60. On Sept. 1, 1940, a blood transfusion of 500 c.c. was given and repeated on

Sept. 4. Then on Sept. 6 the soft palate was split and retracted and an extensive coagulation was performed under intratracheal nitrous oxide anesthesia. The bleeding was moderate and readily controlled by a postnasal pack left in situ for twelve hours. X-ray revealed a cloudiness of the left antrum and the left ethmoid. By Dec. 9, 1940, the tumor mass had again recurred to a size exceeding that noted before the last coagulation. It was the impression that the growth was actually stimulated by partial coagulation whenever a small amount of tissue, including the fibroperiosteal base, was left. The tumor occupied two-thirds of the nasopharynx, obstructing both choanae and the left tubal orifice. Tinnitus and decreased hearing on the right side were noted. The Weber test was lateralized to the right and the Rinne test was positive.

On Dec. 16, 1940, a partial electrocoagulation, under pentothal intravenous anesthesia, was performed. Excessive bleeding occurred requiring transfusions. On April 19, 1941, the patient was seen again. There was occasional bleeding in the interim. A partial electrocoagulation was performed. There were 4,900,000 erythrocytes present in the blood. Through the courtesy of Dr. J. A. Weiss I saw the patient for the first time on May 5, 1941. The examination revealed the following: The patient was pale and there was a scar along the left mandibular angle. The glands of the neck were not enlarged. There was pus on the floor of the left nostril. In the posterior part of the left half of the nose, there was a tumor replacing the inferior and middle turbinates and apparently extending upward beyond the middle turbinate. The tumor has a rough surface and was covered with pus and a gray membrane. There were no signs of a recent hemorrhage. The left choana was entirely obstructed. In the soft palate above the uvula there was a scar extending into the two tonsillar arches on the left side. The posterior wall of the pharynx showed many granula areas. In the epipharynx there was a cauliflower-like tumor covered with pus and a gray membrane. The tumor apparently originated from the superior and lateral margins of the left choana with a broad base and filled the greater part of the epipharynx. However, the opening of the right eustachian tube and the inferior part of the right choana could be seen. The septum was covered by the tumor. The blood count revealed 5,200,000 erythrocytes and 8,900 leucocytes.

On Aug. 6, 1941, under intratracheal anesthesia with nitrous oxide the incision after Oehngren was made. In the canine fossa there was an irregularly shaped defect in the bone which was approximately the size of a cherry stone. Along the margins of this defect the mucous membrane of the maxillary sinus was adherent to the skin. A large opening was made in the canine fossa and the inferior part of the apertura piriformis was removed. The mucous membrane of the maxillary sinus was normal. The mesial part of the posterior wall of the maxillary sinus as well as the floor of the ethmoid were absent and were replaced by a soft tumor covered by a gray membrane. The tumor filled the entire ethmoid and could easily be removed by means of finger dissection from the right lateral wall of the epipharynx, from the roof of the epipharynx, and from the posterior margin of the septum. Much more difficult was the separation of the tumor from the lateral margin of the left choana and from the pterygomaxillary fossa. The incisions of the skin and of the mucous membrane of the mouth were sutured and the large cavity in the nose and in the pharynx was drained through the nose. A posterior tampon was placed in the epipharynx. The operation was accompanied by a considerable venous hemorrhage, which, however, could be controlled by the packing. During the entire operation the patient received a drop infusion of physiologic salt solution and later of blood.



Fig. 8.—Oblique horizontal section through the roof of the epipharynx of a male newborn. *M.* *M. longus capitis*. *FC* Fascia basalis with enlarged blood vessels in the midline. *a.* Pharyngeal hypophysis. *CV.* Canalis vidianus. *II.* Second branch of trigeminus. *Am.* Ala magna of sphenoid. *Fp.* Pterygopalatine fossa. *O.* Orbit. *P.* Pterygoid process. *Lp.* Lamina papyracea. *n.* Posterior end of the cartilaginous ethmoid capsule. *x.* Insertion of fascia basalis at the ethmoid. *Rs.* Sphenothmoidal recess. *A.* Ala vomeris. *R.* Rostrum with synchondrosis intersphenoidalis. *GS.* Sphenopalatine ganglion. *c.* Sphenopalatine foramen.

The patient made an uneventful recovery, but after the removal of the posterior pack four days after the operation, it was noted that only the part of the tumor occupying the ethmoid, the pterygomaxillary fossa, and the epipharynx had been removed at operation, while the other part of the tumor with a broad base situated at the junction of the epipharynx and mesopharynx and originating at the lateral margin of the left choana, remained. Therefore, on Aug. 28, 1941, an attempt was made to remove the remaining tumor through the mouth. The patient received 0.1 gr. of morphine and 0.02 gr. of scopolamine and 2 gm. sodium pentothal intravenously. However, it was impossible to perform the operation inasmuch as the patient immediately stopped breathing when the mouth gag was inserted. Since a normal breathing did not occur even when the tongue was pulled out forcefully, the operation had to be postponed.

On Sept. 5, 1941, the patient received morphine, scopolamine and avertin. Intratracheal anesthesia was administered with nitrous oxide. During the operation the patient received a drop infusion of salt solution. The maxillary sinus was re-opened. In the anterior part of the sinus there was a thick membrane separating the sinus from the nose while in the posterior part of the sinus both cavities were communicating freely. The ethmoid was filled with granulations. The tumor had

a cauliflower-like appearance and was covered by a gray membrane. It filled the entire nasopharynx. Because the tumor was very fragile it could not be grasped in toto and the removal of pieces was followed by considerable bleeding. However, it was possible to stop the bleeding with hydrogen peroxide. It was very difficult to free the tumor, since firm adhesions, perhaps due to the preceding treatment with rays and coagulation, made the tumor adherent to the soft palate, the posterior wall and the lateral walls of the epipharynx. The bleeding following the liberation of the tumor was definitely less marked than it was following the use of the grasping forceps. The tumor was removed by morcellation. After its removal there was a large communication between naso- and oropharynx. The walls of the nasopharynx were rough, covered with remnants of the adhesions. In the upper part of the posterior wall the vertebra was exposed. Posterior tamponade and drainage through the nose were carried out and the mouth wound was closed.

The patient made an uneventful recovery and the air passages were entirely free. Posterior rhinoscopy revealed that the posterior part of the vomer was entirely absent. But there was still tumor tissue as big as a cherry, with a broad base at the inferior and lateral part of the left choana. The tumor consisted of very soft (necrotic?) tissue and was gradually removed by electrocoagulation. The turbinates on the left side were present and the ethmoid on the left side was open.*

The entire tumor weighed approximately 16 gm., had a cauliflower-like appearance and was covered by a gray membrane. It had partly a firm consistency and contained what looked like an enlarged vein.

The structure of the tumor varies on different places. The greater part of the tumor consists of a dense connective tissue with many nuclei. There were numerous capillaries, the walls of which consisted of only a delicate endothelium. Some of these blood vessels were markedly dilated, forming cavernous spaces which contained thrombi of fibrin. There was a cyst as large as a pea which had appeared macroscopically like a dilated vein. The cyst contained fresh blood and was lined by an endothelium. Consequently, the cyst must be considered as a cavernous space which is maximally dilated. A part of the wall of the cyst was very thin although it consisted of tumor tissue and it was obvious that a slight mechanical injury could rupture that part of the wall, thereby producing considerable bleeding.

Other parts of the tumor showed a hyaline area around the large veins that might spread into the adjacent parts of the tumor. Another part of the tumor consisted of simply necrotic tissue with only very few nuclei. In such areas the endothelial cells of the capillaries might still have a normal appearance while on other places also the endothelial cells had disappeared, and the tissue was entirely necrotic. In these areas the blood vessels were filled with thrombi of fibrin. Finally, there were parts of the tumor which did not show either hyalin degeneration or simple necrosis, which rather showed an infiltration by polymorphonuclear cells.

There was, as a rule, a sharp margin between tumor and mucous membrane. The mucous membrane was covered partly by a squamous, partly by a columnar, epithelium and was on some places edematous, and on others fibrotic. Glands were absent, but there were spicules of bone embedded in the mucous membrane and covered by a distinct periosteum.

The mucous membrane of the ethmoid was edematous, but did not show any infiltration. The glands were quiescent, active, or exhausted.

*There was no more nosebleeding up to February, 1942.

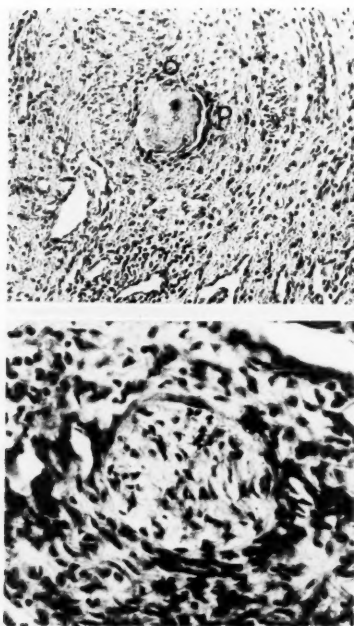


Fig. 9. Case 2.—A. Bone chips within the tumor. *p.* Periosteum. *o.* Osteoclast. B. Nerve surrounded by tumor tissue.

According to the classical descriptions of Testut,³³ Cunningham,⁶ and Schaffer,²⁶ the walls of the nasopharynx consist of a strong, fibrous membrane to which various names are given. According to Testut and Gray this membrane is termed "pharyngeal aponeurosis". It is lined internally by mucous membrane while on the outer surface it is covered by the constrictor muscles of the pharynx. Testut³³ considers this aponeurosis as the tendon of insertion for the constrictor muscles. These muscles, in turn, are covered externally by a thin layer of fascia which at its superior part passes forward on the surface of the buccinator muscle and is called the "buccopharyngeal fascia". The pharyngeal aponeurosis which is thick above and thin below, and the buccopharyngeal fascia, which is thin above and stouter below, are practically blended into one layer close to the base of the skull where the superior constrictor muscle is absent on each side. This area is called the "sinus of Morgagni". However, in the sinus of Morgagni not only the pharyngeal aponeurosis and the buccopharyngeal fascia become united, but according to the textbooks, the connective tissue also blends into the periosteum of the

basilar portion of the occipital bone and of the sphenoid body. Thus, a very thick layer of connective tissue is formed at the base of the skull which is only found in human beings and which Killian¹⁸ considers as a remnant of the chorda dorsalis. This connective tissue is usually called "fibrocartilago basilaris". However, since we did not find any cartilage in that tissue in newborn infants, that connective tissue is best called "fascia basalis". On each side the pharyngeal aponeurosis is attached by a very irregular insertion to the mesial pterygoid lamina, the pterygomandibular ligament, the mylohyoid ridge and is eventually lost on the side of the tongue. In a downward direction, the pharyngeal aponeurosis passes over into the submucosa of the esophagus.

In order to become better acquainted with the mucous membrane of the nasopharynx, serial sections were prepared through the nasopharynx of two newborn infants, the one being a male, the other a female sex. The female skull was cut in the frontal level, the male skull in the horizontal level.

The epithelium of the nasopharynx is, to a great extent, columnar in character lying on a definite basal membrane. Although, in general, the epithelium does not show any mucous degeneration, there are occasionally in the depth of the crypts epithelium cells changed into goblet cells. Toward the oropharynx, islands of squamous epithelium can be found, particularly in the depth of the crypts of the adenoids. On these sites the squamous epithelium sends ramified plugs of epithelium into the adenoid tissue. Thus, occasionally one finds plaques of squamous epithelium in a section through the adenoid tissue.

The adenoid tissue is more developed in the male skull than in the female. Follicles are lacking in the female skull, but they are present in the male. There are many blood vessels with delicate walls and a relatively large lumen. Occasionally one meets with epidermis pearls. Toward the mouth as well as toward the roof of the nasopharynx the adenoid tissue gradually disappears.

The glands are of a mucous character in the inferior part of the nasopharynx while in the upper part, mixed glands of nasal type are prevalent. The glands are adjacent to the adenoid tissue and their excretory ducts are frequently loaded with mucus which pours into the depth of the crypts. Toward the roof of the nasopharynx as well as toward the opening of the eustachian tube the number of glands increases and they gradually move into the deep layers of the mucous membrane. It is noteworthy that in the midline there is never an accumulation of glands.

In the male skull the superior constrictor muscle extends closer to the base than in the female skull. Consequently, the fusion of the pharyngeal aponeurosis and the buccopharyngeal fascia, resulting in the formation of the fascia basalis, takes place closer to the base of the skull in the male than in the female.

The fascia basalis in the posterior wall of the nasopharynx consists of a thick layer of connective tissue, on each side bounded by the longus capitis muscle. In the female specimen two types of connective tissue were found (Fig. 5). In the region of the midline a loose tissue was present which contained small cavities and gave the impression of an immature connective tissue. This tissue harbored several arterioles and many capillaries, the walls of which consisted only of endothelium and the lumen of which was very large. One of these capillaries perforated the periosteum of the vertebra and extended into the marrow spaces of the vertebral body.

Since the epithelium of the mucous membrane formed a sulcus in the midline, this loose connective tissue showed a different development, dependent upon the depth of the invagination of the epithelium, which occasionally even reached the periosteum of the vertebra, compressing the connective tissue of the midline to a very small layer.

On both sides of the midline the fascia basalis consisted of fibers which were firmly attached to one another, contained few nuclei, and extended from the nasopharynx toward the hypopharynx. Also in this portion of the fascia basalis there were some capillaries with a simple endothelial wall and a large lumen; however, they were never so numerous as were those situated in the midline.

The connective tissue of the fascia basalis which had developed by the union of the pharyngeal aponeurosis and the buccopharyngeal fascia was distinctly separated from the adenoid tissue of the mucous membrane. The same distinct boundary was also found between the fascia basalis and the periosteum of the vertebra of the base of the skull (Figs. 5-7). The fibers of the periosteum encircled the vertebra while the fibers of the fascia basalis, to a great extent, coursed from upward downward. The fibers of the periosteum were thicker than those of the fascia basalis and stained slightly with hematoxylin, while the fibers of the fascia basalis stained distinctly with eosin. In contrast to the textbook descriptions, we find, therefore, that the fascia basalis does not blend into the periosteum. The two layers of connective tissue rather differ (1) by the structure of their fibers, (2) by the course of their fibers, and (3) by their osteogenetic power which is lacking so far as the fascia basalis is

concerned. Consequently, the fascia basalis does not consist of the pharyngeal aponeurosis plus buccopharyngeal fascia plus periosteum. It rather consists only of the pharyngeal aponeurosis plus the buccopharyngeal fascia, the pharyngeal aponeurosis furnishing the major part.

Toward the roof of the nasopharynx the fascia basalis increases to an amazing degree, in the male specimen as well as in the female, inasmuch as it is enforced by the ligamenta pharyngis lateralia of Tortuol which originate on the basal surface of the temporal bone. The fascia basalis, therefore, can even be seen macroscopically at the roof of the nasopharynx of the newborn infants. Microscopically, the fascia basalis covers the floor of the sphenoid and extends laterally toward the muscles of the eustachian tube (Fig. 5). However, it does not continue beyond the eustachian tube. Toward the nose, the fascia basalis is situated to both sides of the rostrum of the sphenoid and passes over into the periosteum of the alae vomeris. Laterally, the fascia basalis is adjacent to the sphenopalatine ganglion and makes its insertion on the palatal bone and the posterior end of the cartilaginous ethmoid capsule (Fig. 8).

As on the posterior wall of the nasopharynx, the fascia basalis also consists at the floor of the sphenoid partly of firm connective tissue situated to both sides of the rostrum and partly of loose connective tissue in the midline, particularly behind the rostrum (Fig. 8). In this loose connective tissue the pharyngeal hypophysis is embedded just behind the rostrum, where there are also located very large blood vessels, almost cavernous spaces, in the male skull (Fig. 8). The same large blood vessels, with the simple endothelial wall, but in a smaller number, are also found in the lateral parts of the fascia basalis.

The fascia basalis not only covers the floor of the sphenoid, extending from the posterior wall of the nasopharynx into the nose, but it also invades the body of the sphenoid above the Vidian canal, reaching the periosteum of the superior orbital fissure (Figs. 6 and 7). This channel is probably identical with the canalis cranio-pharyngeus lateralis, described by Sternberg²¹ many years ago. Another portion of the fascia basalis invades the sphenoid body in the direction toward the planum sphenoidale (Fig. 7). This portion meets within the sphenoid body with fibrous bands originating in the dura of the anterior fossa and perforating the planum sphenoidale. Therefore, in newborn infants there are large connective tissue strands connecting the mucous membrane of the nasopharynx with the periosteum of the superior orbital fissure and with the dura of the planum sphenoidale (Fig. 7).

Summarizing, we find that the fascia basalis covers the posterior wall of the nasopharynx and the roof of the epipharynx, viz., the floor of the sphenoid, while it is more or less lacking in the lateral wall of the epipharynx. The fascia makes its anterior insertion at the palatal bone, at the posterior ethmoid (Fig. 8), at the vomer, and to a lesser extent at the mesial lamella of the pterygoid process. Microscopically, the fascia basalis can be separated from the periosteum, inasmuch as the fascia basalis does not possess an osteogenetic power. But the fascia contains conspicuously many blood vessels (Figs. 5 and 8), particularly in the region of the midline. Many of these blood vessels show a very large lumen and a simple endothelial wall.

Although we did not examine the nasopharynx of adults microscopically, there can be no doubt that the fascia basalis of the newborn infant undergoes a retrogression after birth. The subsequent appearance of the sphenoidal sinus and the later disappearance of the different channels perforating the sphenoidal body seem to verify this point. Nevertheless, one can be certain that the fascia basalis of adults may be found essentially occupying the same location in the nasopharynx as has been described in the nasopharynx of the newborn infant.

It must be emphasized that in the two specimens examined, there were some differences concerning the structure of the mucous membrane of the nasopharynx. However, I am not able to say whether these differences were individual or if they were dependent upon the sex. Further anatomical examinations in this direction would be of great help.

It was very often emphasized that the structure of the tumor differed not only from case to case but also on different sites of the same specimen. Since it was impossible to examine microscopically the entire tumor, we excised small pieces from different parts of the tumor and examined parts of these by serial sections.

The tumor in Case 2 chiefly consisted of firm connective tissue which here and there contained so many nuclei that the tissue resembled a sarcoma. However, these tumors should not be called sarcoma inasmuch as the clinical symptoms, the uniformity of the nuclei, and the great number of fibrils were not in favor of such a diagnosis. It seems rather reasonable to designate these tumors as immature fibromas, since Schmidtman²⁷ also emphasizes that these tumors contain many accumulations of immature connective tissue cells. Whether or not these tumors can be transformed into actual

sarcomas can not be said from the study of our cases; however, the majority of investigators deny this possibility.

The tumor in Case 3 also showed areas with numerous nuclei although their number did not approach those observed in Case 2. The greater part of that tumor contained only a small number of nuclei; there were even irregular areas of hyalin degeneration and beginning disintegration of the tissue as Ballo² observed in his cases. Undoubtedly this hyalin degeneration ushered in the spontaneous involution of these tumors as already indicated by Ballo.²

The tumor of Case 4 had a structure similar to that of Case 3. However, this tumor differed in three points from the tumors in the other cases. First, large areas of this tumor showed a simple necrosis of the tissue and not a hyalin degeneration. This necrosis was characterized by the disappearance of the nuclei. It is important that the nuclei of the tumor tissue disappear first and later the nuclei of the capillaries. The necrosis was due to the obstruction of the blood vessels by thrombi of fibrin. Second, parts of the tumor revealed a marked infiltration of polymorphonuclear cells. Third, the tumor of Case 4 evidenced considerable enlargement of the blood vessels to such an extent that actual cysts were formed. Since these cysts contained blood they might have been the source of a hemorrhage.

All of these findings were signs of an involution of the tumor. Consequently, our cases presented three findings indicating a spontaneous involution of the tumor: (1) hyalin degeneration, (2) simple necrosis, and (3) formation of cysts.

We did not find elastic tissue in either of the tumors examined except around the blood vessels. We also failed to find the myxomatous structures as described by Sébilleau.²⁸ Summarizing, we consider nasopharyngeal fibromas as immature fibromas with an individual variability of their structure. These tumors became manifest in young men, as a rule, between the eighth and tenth years of life. The fact that in the history of many of these cases an adenoidectomy is mentioned (Cases 2 and 4) which was performed without difficulty proves that these tumors, as a rule, are not present as macroscopic growths before the aforementioned age. In Case 2, the adenoids were even removed twice, the last time one and one-half years before I saw the patient suffering from a tumor which filled the entire nasopharynx. It is quite impossible that the surgeon who performed the adenoidectomy would have overlooked a nasopharyngeal tumor. At least, the hemorrhage would have aroused his atten-

tion to the fact that he was not dealing with adenoids but with a nasopharyngeal fibroma. But since the adenoidectomy was followed by an uneventful recovery, we must suppose that at the time of that operation there was as yet no macroscopic tumor, which, consequently, grew in one and one-half years to a quite considerable size.

Furthermore, these tumors do not show an unlimited growth such as do malignant tumors; on the contrary, after a number of years these tumors become mature, undergo senescence, and finally are resorbed or expelled, unless they perforate the base of the skull as indicated in Case 1. In agreement with Ballo² I believe that the involution of these tumors depends chiefly, but not entirely, on pathologic changes of the blood vessels. From these facts it follows that nasopharyngeal fibromas have a life cycle similar to the nasopharyngeal tonsils, and, thus, these tumors resemble organs more than they do neoplasms.

Besides the connective tissue, the tumors contain blood vessels which were very numerous particularly in Case 2. The great number of blood vessels found in these tumors is well known and, therefore, Friedberg¹⁰ is correct in proposing to call these tumors vascular fibromas. However, not sufficient stress was laid upon the fact that these tumors contain three different types of blood vessels: (1) very primitive blood vessels, the walls of which consist of a delicate endothelium only; (2) veins; and (3) small arteries. The primitive blood vessels belong to the tumor proper, forming an integral part of it, although blood vessels of the same structure have been found in the pharyngeal mucous membrane of newborn infants. The lumina of these blood vessels alter greatly; in some sections it is slit-like, while in others it expands to wide, cavernous spaces into which occasionally extend valvelike formations consisting of tumor tissue. In Case 4 an actual cyst containing blood was formed. It was often emphasized that these blood vessels cannot contract, because their walls do not contain muscular nor elastic tissue.

The veins and the small arteries do not belong to the tumor proper; they rather belong to the mucous membrane which is the source of the neoplasm, and are only included into the growing tumor, a fact which can be readily proved by serial sections.

It is interesting to examine the relations between these two vascular systems. It was possible to carry out this examination on the tumor of Case 2 and the following conclusions could be drawn from this study: No large communication exists between the two vascular systems; only occasionally does one meet with a fine blood vessel of

the tumor draining into a vein (Fig. 2). However, this finding is rare. Never do the blood vessels of the tumor drain into an artery.

Frequently, the blood vessels of the tumor surround the blood vessels of the mucous membrane in a garland-like array, so that occasionally three-quarters of the wall of the latter are surrounded by the blood vessels of the tumor (Fig. 2). While the blood vessels of the tumor never invade the walls of the arteries and are rather separated from the adventitia by a thin layer of tumor tissue, they frequently advance up to the endothelium of the veins, and may even bulge the walls of the veins into the lumen. Thus, a contact for an osmosis is established between the contents of the veins and the contents of the blood vessels of the tumor.

We find that in Case 2 there was an anatomic as well as physiologic communication between the blood vessels of the tumor and the veins of the mucous membrane, while such a communication between the blood vessels of the tumor and the arteries of the mucous membrane was absent.

When the tumor becomes older the blood vessels undergo various changes which are described by Ballo² and others and which are also verified in Cases 3 and 4. There was a thickness of the wall of the small arteries entering the tumor, hyalin and fibrinous thrombi of the larger veins of the tumor, hyalin degeneration around the small blood vessels of the tumor, necrosis of the wall of the blood vessels, and cyst formation. It must be emphasized that in Case 3 we noted a destruction of the blood vessels of the tumor by angiolytic, such as is found when capillaries are destroyed during the embryonic period of life, a finding which actually indicated a destruction and not a formation of new blood vessels. We always found the angiolytic in areas of incipient or progressed hyalin degeneration.

In the tumor of Case 2 we found spicules of bone within the tumor tissue. This finding is surprising inasmuch as almost all pathologists emphasize that nasopharyngeal fibromas do not contain bone, calcium, or cartilage. A thorough examination proved that Case 2 was no exception to the rule. There was bone within the tumor. However, this bone was not due to an ossification of the tumor tissue; it was rather bone of the nasal framework, particularly of the ethmoid, which was included within the growing tumor, while in Case 4 the spicules were embedded in the mucous membrane. For this reason the bony spicules were surrounded by a distinct periosteum containing many nuclei. It is probable that these bony spicules would have been destroyed later inasmuch as osteoclasts

were observed in Case 2, and since in the serial sections of Case 3 there were no bony spicules at all. Therefore, we must agree with the majority of pathologists who, as a rule, did not find signs of ossification in nasopharyngeal fibromas. The frequently quoted cases of Glas¹¹ and Cloquet which are supposed to prove the contrary were not typical cases of nasopharyngeal fibromas, inasmuch as Glas' patient was a woman 64 years old, and Cloquet's patient was a 50-year-old woman. Guessow¹² found bony spicules within the base of the tumor. However, it seems that also in his case the bony spicules were not produced by an ossification of tumor tissue, but rather were parts of the sphenoid body invaded by the tumor.

Most surprising was the finding of nerves within the tumors of Cases 2 and 3. These nerves in Case 2 presented definite signs of degeneration, and it is probable that most of them disappear when the tumor grows older. Frequently, the nerves were found accompanying the blood vessels of the mucous membrane. This finding is surprising because we know that, in general, tumors do not contain nerves.

It is well known that there exists an expansive and infiltrative growth of tumor, in general. Nasopharyngeal fibromas are supposed to grow by expansion as it is characteristic for the majority of benign tumors. Some authors state that these tumors grow slowly. According to my experience these tumors, on the contrary, grow rapidly, the primary tumor as well as the recurrences. They invade all pre-existent slits and openings of the base of the skull. Furthermore, they push ahead of the mucous membrane of the nasopharynx and of the posterior part of the nose. This mucous membrane reveals variable changes. On some sites, it is edematous, on others it appears compressed, again on other places it shows a fibrosis and, finally, in some areas it is approximately normal. On all sites, however, the glands of the mucous membrane degenerate. I have never seen a cystic degeneration of the glands, as indicated by Sébilleau.²⁸ If the disease lasts long enough and the tumor reaches considerable size, the mucous membrane finally is entirely destroyed. However, even in small tumors, as in Case 2, the tumor occasionally reaches the epithelium of the mucous membrane. Considering this fact, it is surprising that one does not frequently meet with ulcerations of these tumors. Sébilleau²⁸ even emphasizes that these tumors never show ulcerations. However, this statement is too all inclusive inasmuch as ulcerations occasionally can be demonstrated. Nevertheless, it is noteworthy that ulcerations occur but seldom, even in large tumors.

There is some difficulty, however, in adapting the finding of nerves within the tumors to the concept of the expansive growth of these tumors, because nerves are only occasionally observed in tumors which grow by infiltration, as shown by Young³⁴ many years ago. Consequently, this finding would indicate a growth of nasopharyngeal fibromas by infiltration rather than a growth by expansion. Furthermore, the occasional perforation of the base of the skull by these tumors and their tendency to recurrences also indicates a certain malignant trend of these tumors. As far as recurrences are concerned, Sébilleau²⁸ doubts this tendency; he believes rather that the so-called recurrences are actually due to an incomplete operation. Although I entirely agree with Sébilleau,²⁸ Case 2 seems to prove that actual recurrences occasionally occur. In this case probably the entire tumor was removed, its surface being covered, to a great extent, by mucous membrane. Nevertheless, a new tumor arose, probably originating on another place than the original tumor. Coates⁴ also observed a case with one tumor in the nasopharynx and another in the right nasal chamber. Contrary to all these findings the spontaneous involution of these tumors, the absence of metastases, the encapsulation, and the lacking cachexia point to a benign character of these tumors.

According to the structure, the growth, and the symptomatology the nasopharyngeal fibromas are neither typically malignant nor benign tumors, but rather occupy an intermediary position, and it is very probable that these tumors change from case to case so far as their biologic character is concerned. Perhaps this variability is due to a multicentric origin of these tumors, viz., to the possibility that several centers from which tumor cells originate appear simultaneously as indicated already by Coates.⁴ When these centers gradually coalesce, producing one large tumor area, the cauliflower-like appearance of these tumors and the inclusion of nerves and bone can be easily explained. However, this is only an hypothesis.

The older surgeons believed that these tumors originated at the inferior surface of the sphenoid body and of the basilar portion of the occipital bone. They, consequently, considered them as pharyngeal tumors invading the nose secondarily. On the other hand, Jaques¹⁷ and many rhinologists of the French school considered these tumors as nasal tumors secondarily invading the pharynx and originating in the posterior part of the nose. This question has raised an extensive discussion, until Denker,⁷ Coates,⁴ Sébilleau,²⁸ and Coenen⁵ and many others decided, as did Hyrtl¹⁶ in 1882, that

these tumors originate at the roof of the epipharynx as well as at the framework of the choanae, viz., in the posterior part of the nose, the latter finding being more frequent. Denker⁷ found among twelve cases an extrapharyngeal origin in the fossa sphenomaxillaris in two cases and in ten cases an intrapharyngeal or intranasal origin. Three of the latter cases originated at the fibrocartilago basilaris, three at the anterior wall of the sphenoid sinus, and four at the pterygoid process or the vomer.

I believe the question is of minor importance from the theoretical as well as from the practical point of view. As Sébilleau²⁸ has already emphasized, the findings during the operation as a rule do not permit definite conclusions concerning the origin of these tumors and the autopsy findings are of value only if they concern small tumors. Perhaps the case of Guessow¹² concerning a man, 20 years old, who died from a hemorrhage originating in a nasopharyngeal fibroma is of importance. In this case the tumor originated at the fascia basalis and invaded the sphenoid body as well as the basilar portion of the occipital bone, but had no connection with the sphenoccipital synchondrosis. Similarly an autopsy case of Coenen⁵ showed the inferior part of the sphenoccipital synchondrosis was invaded by the tumor. The other autopsied cases of nasopharyngeal fibromas (Denker,⁷ Koch,¹⁹ and others) concern such large tumors that it is impossible to find the point of origin. The two cases of Guessow¹² and Coenen⁵ do not allow general conclusions regarding the point of origin of these tumors.

Furthermore, even supposing one could determine the point of origin in every case, this knowledge would have little practical value, since, at present, the treatment does not depend upon the question as to whether these tumors are primarily nasal or primarily pharyngeal tumors. It is of greater importance to discern the matrix of these tumors.

Coenen⁵ emphasized that remnants of the chondrocranium presented the matrix of nasopharyngeal fibromas, these tumors being actually tumors of the skeleton. According to Coenen,⁵ parts of the chondrocranium, located within the sphenoccipital synchondrosis, are displaced, fail to ossify, and rather evidence a regressive development into connective tissue. From these "anaplastic" remnants of the chondrocranium, nasopharyngeal fibromas are supposed to originate. This theory can not be accepted inasmuch as Stoccarda³² has proved that the connective tissue at the inferior surface of the base of the skull is not derived from the chondrocranium.

The majority of investigators consider these tumors as of periosteal origin and Sébilleau²⁸ calls them simple hyperplasias of the periosteum. The same author also presents a microscopic specimen which is supposed to prove the periosteal origin of these tumors. However, since in his specimen the fibers of the tumor run almost perpendicularly toward the fibers of the periosteum (as also emphasized by Sébilleau²⁸), it is very difficult to believe that there is a connection between the fibers of the tumor and the fibers of the periosteum. The specimen presented by Sébilleau²⁸ could rather prove that there is no connection between these two groups of fibers. Furthermore, it is astonishing that nasopharyngeal tumors almost never present ossification or calcification of the tissue. This fact becomes even more surprising when one compares the structure of these tumors with the structure of actual periosteal fibromas of the maxilla.

In a tumor removed by Dr. F. L. Lederer from the left superior maxilla of a 29-year-old woman, the tumor consisted of connective tissue, the fibers of which ran in all directions. On some sites the connective tissue contained so many cells that the first impression was that of a sarcoma. However, there were also many areas of hyalin degeneration and there were pearl-like formations which were also hyalinized. There were no elastic fibers and only scanty numbers of blood vessels. The tumor was covered by the periosteum of the maxilla which still contained thin plates of bone. Seldom did these bony plates, the margins of which were, to a great extent, aplastic, invade the tumor.

Most conspicuous, however, was the enormous calcification, particularly of the center of the tumor. The calcium most frequently occupied the hyalinized areas. However, calcium was also found between the fibers and the cells of the connective tissue, in the latter case the calcium being separated from the membrane of the cell by a fine, probably artificial slit. Later the cells disappeared and there were only small openings within the calcium. The calcium also surrounded small veins without reaching the endothelium. There was, as a rule, necrotic connective tissue between the ring of calcium and the endothelium. In sections, stained following the technic of Pap, every piece of calcium was surrounded by a delicate capsule of argyrophile fibers and, occasionally, within the calcium decaying fibers were found. Bone was not observed in the tumor.

In fact, it is obvious that the structure of an actual periosteal fibroma of the skull differs definitely from the structure of nasopharyngeal fibromas. Consequently, it seems erroneous to call the latter tumors simple periosteal fibromas.

From a clinical and histological point of view, the matrix of nasopharyngeal fibromas must rather fulfill the following requirements:

1. The matrix must be made up of connective tissue.
2. This connective tissue must be found in the pharynx as well as in the posterior part of the nose.

3. The connective tissue must have but a very slight osteogenic power.
4. The connective tissue must be more developed in the nasopharynx than in the oropharynx and laryngopharynx.
5. The connective tissue must be situated on the inside of the superior constrictor muscle.

I should like to lay particular stress on the last point because this apparently has been under-rated. If the nasopharyngeal fibromas developed on the outside of the superior constrictor muscle, the surface of these tumors so far as it bulged into the pharynx, would be covered by muscular tissue. However, such muscular tissue was never found on the surface of the tumors, although small nasopharyngeal fibromas may be covered partly by normal mucous membrane as shown in Case 2. Furthermore, if nasopharyngeal fibromas developed on the outside of the superior constrictor muscle there would be a considerable hazard for the great blood vessels of the neck, the danger increasing markedly after the extirpation of these tumors. The reason for this is that the operation would produce a large opening in the superior constrictor muscle and would expose the great blood vessels of the neck to an infection originating in the pharynx. Up to the present time this danger has never been encountered and patients with nasopharyngeal fibromas seldom, if at all, die of a postoperative bleeding originating from the carotid artery or from the jugular vein. These facts definitely prove that these tumors must develop on the inside of the superior constrictor muscle.

In order to meet the aforementioned requirements, one must recall that the membranous wall of the nasopharynx contains: (1) the buccopharyngeal fascia, (2) the pharyngeal aponeurosis, and (3) the fascia basalis, the result of the fusion of the buccopharyngeal and pharyngeal fascias. The buccopharyngeal fascia seldom produces fibromas. Nevertheless, I had an opportunity to remove such a tumor in a 43-year-old patient, who had a positive blood Wassermann.

The tumor was a hyalinized fibroma and was of grapefruit size. The mass was situated in the left side of the neck and extended from the inferior margin of the mandible down in the posterior mediastinum and extended over the midline to the right side of the neck. The tumor was attached by connective tissue to the posterior wall of the hypopharynx, to the vessel sheath, and to the prevertebral fascia. From these organs the tumor was separated by blunt dissection and the patient made an uneventful recovery except for a left recurrent laryngeal paralysis. There can be no doubt that the fibroma had its origin in the buccopharyngeal fascia in the area of the hypopharynx.

This case proves definitely that the buccopharyngeal fascia might eventually furnish the matrix of fibromas. According to the terminology of uterine fibroids these fibromas could be called "extramural fibromas" of the pharynx inasmuch as they develop more readily in the hypopharynx than in the nasopharynx because the buccopharyngeal fascia becomes thicker in the former site.

Contrary to the buccopharyngeal fascia, the pharyngeal aponeurosis becomes stouter toward the nasopharynx, furnishing the major part of the fascia basalis. Considering the five requirements concerning the matrix of nasopharyngeal fibromas, it is obvious that the fascia basalis exactly fulfills all of these requirements. Consequently, we feel justified in calling the fascia basalis the matrix of nasopharyngeal fibromas. Therefore, because the fascia basalis originates chiefly from the pharyngeal aponeurosis, situated on the inside of the superior constrictor muscle, nasopharyngeal fibromas must be called "intramural fibromas" in contrast to the "extramural fibromas" as described above.

Our concept is apt to explain the following pathological and clinical findings:

1. The tumors originate in the nasopharynx as well as surrounding the choanae; in other words, in all areas where the fascia basalis can be found.

2. The microscopic picture of the tumors is approximately the same as that of the fascia basalis.

3. Inasmuch as the mucous membrane of the nasopharynx, including the fascia basalis, undergoes an involution in the early periods of life, the spontaneous involution of these tumors becomes understandable.

4. Since the matrix of these tumors is found in the entire nasopharynx and in the posterior parts of the nose, the broad base to which these tumors are attached to the site of origin and which is difficult to eradicate is explained. The same facts also account for the recurrence of these tumors prior to their spontaneous involution.

Although our concept explains a number of facts, it can not as yet account for the more prevalent occurrence of these tumors in men and their usual unilateral development. It is possible that further microscopic examinations of the pharyngeal aponeurosis may also in the future furnish an explanation for these facts, inasmuch as the examination of but two specimens presented differences in the structure of the nasopharyngeal mucous membrane.

There is no existing treatment which could be called perfect. At present, the treatment consists chiefly of the application of radium and surgical diathermy. As a matter of fact, Galloway and Friedberg,¹⁰ Figi,⁹ Som and Neffson,³⁹ Hughes,¹⁵ and others believe that this combined form of treatment offers by far the most satisfactory therapeutic approach. The most important advantage of this type of treatment is the possibility to avoid severe hemorrhages.

There is no doubt that one cannot lay enough stress upon the danger of these hemorrhages which are often insidious and mean death of the patient even within few days after the operation. Consequently, Figi⁹ warns that even taking a biopsy in these cases might be dangerous, a situation which is unavoidable because not only do retronasal polyps but reticulomas as well resemble nasopharyngeal fibromas. If the treatment with radium and surgical diathermy would absolutely abolish these hemorrhages, much would be gained. Unfortunately, this is not the case. Pryor²⁵ and Koch and Eigler²⁰ noted severe hemorrhages after removal of radium seeds. Our Cases 1 and 4 prove that surgical diathermy applied after irradiation may be followed by a severe hemorrhage. Of course, it must be admitted that in these cases X-ray and telerradium respectively were applied and not radium seeds. Furthermore, Nelson²³ did not note any favorable result from the use of radium; it obviously could only "tickle the end" of the tumor. Finally, Friedberg¹⁰ failed to find significant histologic changes following irradiation of these tumors. He only had the clinical impression of a decrease of the vascularity of the radiated areas.

I cannot agree that radium therapy may be regarded as the most effective means of reducing the vascularity of the tissue, and see no reason, therefore, why it must be used as a preliminary measure in all instances, inasmuch as the questionable advantage is associated with two and perhaps three disadvantages. First, this form of treatment does not avoid recurrences of the tumor inasmuch as without a large exposure it is difficult to visualize the parts of the tumor hidden in the posterior ethmoid and in the pterygopalatine fossa. Second, the treatment takes a long time. Figi⁹ estimates the duration of the treatment with radium and surgical diathermy at ten months, the duration of the treatment with radium alone at eighteen and one-half months. Koch and Eigler²⁰ treated their patients with X-rays and radium over a period of one to one and one-half years. Such a protracted treatment undoubtedly must meet with difficulties in many cases. Finally, it seems that the treatment by means of radium and surgical diathermy prior to surgery produces very firm adhesions and renders the operation more difficult (Case 4).

Considering these advantages and disadvantages one must admit that there is still room for the consideration of a surgical approach to these tumors. There is, of course, no occasion at this time to discuss the fifty-five surgical approaches recommended in the past for the removal of these tumors (Koch and Eigler²⁰); we are only concerned with the transnasal route, according to the technic of Denker, which may be combined with the incision recommended by Oehngren, as performed in Cases 3 and 4. This technic consists of the typical incision advised by Denker in the vestibulum oris and is continued by an incision through the skin which slits the upper lip in the midline and encircles the ala nasi. This incision leaves an almost invisible scar on the upper lip and furnishes an excellent view of the maxillary sinus, the posterior ethmoid, the sphenoid sinus, and the nasopharynx. Unfortunately the parts of the tumor extending to the oropharynx can be seen only when the assistant places his index finger into the mouth of the patient and pushes the tumor and the soft palate forcefully into the nasopharynx. Consequently, it may happen that the surgeon approaching the tumor through the transmaxillary route may miss parts of the tumor situated in the oropharynx, as resulted in Case 4. Despite this disadvantage I prefer the transmaxillary route against the oral approach, particularly if the latter is combined with splitting of the soft palate. In such a case shortening of the soft palate may result and the patient may meet with difficulties in eating, drinking, and talking when the tumor in this manner is radically removed. If after the transmaxillary operation remnants of tumor are left in the mesopharynx they can readily be destroyed by radium and electrocoagulation, using the peroral route.

So far as the preliminary ligation of the external carotid is concerned, this procedure had been previously performed in Cases 3 and 4 (in the latter the common carotid artery was ligated), but was not carried out in Cases 1 and 2. The experience in the latter two instances proves that the removal of the tumor can be performed without preliminary ligation. Other surgeons had similar experiences. Sébilleau²⁸ and Friedberg¹⁰ believe that ligation may be a valuable adjuvant, while Denker⁷ and Kobylinsky and Nikolsky²¹ do not ascribe any value to the procedure. However, inasmuch as a part of the hemorrhage during the operation does not originate in the tumor but in the mucous membrane, and since the blood vessels of the tumor communicate with the blood vessels of the mucous membrane, one can assume that the ligation of the external carotid artery might occasionally diminish the hemorrhage to a small degree. More will not be achieved, even by a bilateral ligation, because the

severe hemorrhages in these cases frequently are of venous origin and may result from a regurgitation of blood from the jugular vein. In a recent case of Munson,²² the external carotids on both sides and the common carotid on the diseased side were ligated without influencing the hemorrhage from the tumor.

The surgical approach has one definite advantage. It may cure the patient in a short time, occasionally for a limited time, and occasionally for ever. The disadvantages are that the surgical approach too does not absolutely avoid recurrences, as shown in Case 2, and that the danger of severe hemorrhage is far greater. So far as the dangers of the operation are concerned, there are various opinions voiced. Shaheen²⁹ does not consider the operation as particularly difficult and believes that it can be performed in five to fifteen minutes. On the other hand, Hellat¹⁴ claims that the operation leads to a fatality in one-sixth of the cases; Koch and Eigler²⁰ estimate the surgical mortality at 10 to 20 per cent. Kobylinsky²⁴ reviewed 284 cases from the literature and found that in 10.9 per cent of patients the operation led to a fatality. These variable opinions require some comment. The statement of Shaheen²⁹ can be properly understood only if one bears in mind that the author was not concerned solely with nasopharyngeal fibromas and that among his own 58 cases there were 4 fatalities (almost 7 per cent). The statistics of Hellat¹⁴ on the other hand, include cases which were approached by the formidable, mutilating operations such as resection of the superior maxilla, displacement of the nose, etc. Such procedures are abandoned by the majority of surgeons today. The dangers of these mutilating operations can be convincingly proved by the statistics of Nikolsky,²⁴ who reports 18 cases with 3 fatalities (almost 17 per cent). Twelve of these 18 patients were operated upon through the mouth or through the nose without a fatality. In 6 cases partial or complete resection of the maxilla was performed as a preliminary operation, and out of these cases 3 patients died. These observations illustrate clearly the grave danger of such mutilating procedures, particularly when these operations are performed under chloroform anesthesia, as in the cases of Nikolsky.²⁴

Considering these facts, one certainly should not under-rate the magnitude of the operation. However, if one recalls that Denker⁷ lost only 1 patient out of 12 treated by surgery, and in this one instance the tumor had perforated the base of the skull, there is no apparent reason to exaggerate this danger. Furthermore, we had no fatality among our 4 cases.

Surgery as well as the more conservative measures of radium and surgical diathermy are suitable for the treatment of nasopharyngeal fibromas and, thus, the question arises when to employ surgery and when to indicate the more conservative treatment. Although my limited experience with these cases does not entirely justify definite conclusions, at present I favor surgery in the following types of cases: (1) in older individuals, since we may expect a more or less extensive degeneration of the tumor tissue in such cases; (2) in very large tumors, because naturally a large tumor will considerably increase the time necessary for the conservative treatment and hidden extensions of the tumor may readily be overlooked if the tumor is not thoroughly exposed by surgical means. More conservative measures seem to be indicated in the following cases: (1) Patients who suffer from a severe hemorrhage in taking the biopsy, pointing out the possible difficulties which might arise during an operation; (2) cases which offer a doubtful microscopic finding of biopsy suggesting a sarcomatous degeneration of the tumor; (3) a poor general condition of the patient, which would permit surgery only after a preliminary building-up of the patient; (4) recurrence of the tumor which can be more readily managed with radium and surgical diathermy, provided it does not reach a considerable size; and (5) signs of intracranial involvement, making the outlook questionable for any form of treatment. It must be borne in mind that in the last such signs are frequently absent even though the tumor may have penetrated the base of the skull. It is obvious that these indications cannot be viewed as too definite inasmuch as the number of cases at the disposal of the writer were limited.

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IV

THE KING OPERATION FOR BILATERAL ABDUCTOR PARALYSIS OF THE VOCAL CORDS*

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CHICAGO

King,¹ in 1939, presented a new operation for the relief of bilateral paralysis of the vocal cords. He "borrowed from the procedures and practices of orthopedic surgeons" and devised an ingenious orthopedic operation on the cricoarytenoid joint. The basic principle of the operation consists of the division of the capsule of the cricoarytenoid joint, mobilization of the arytenoid cartilage to which the vocal cord is attached, and the fixation of the arytenoid cartilage to the thyroid cartilage in an abducted position, thus fixing the vocal cord in an abducted position. In addition, he sutured the cut end of the omohyoid muscle to the muscular process of the arytenoid cartilage with the hope of thus obtaining some active motion of the vocal cord. In his second article,² he reported the results of 13 operations performed on 12 patients. Of these, 8 had a good voice and 8 had a good airway, 7 were able to dispense with their tracheotomy tubes. In a personal communication he states that in 10 succeeding cases the results have been much better than in his first series. He has had no deaths. There seems to be little doubt that the operation is the most satisfactory one thus far devised for this condition. Heretofore, the majority of patients have been subjected to a permanent tracheotomy. Nerve suture has been uniformly unsuccessful. Cordotomy, cordectomy, and cord displacement operations performed from within the larynx have produced a loss of voice and in many cases, as the years pass, fibrosis, contractions, and laryngeal stenosis. The King operation gives a reasonably adequate breathing space and, at the same time, maintains a reasonably adequate speaking voice.

Although the operation is not an exceedingly difficult one to perform, the surgical approach is a rather unfamiliar one to most surgeons. This paper is designed primarily to illustrate the anatomical landmarks and to describe the technic. The illustrations were

*Presented before the Chicago Laryngological and Otological Society, April 7, 1941.

drawn from dissections of both fresh and preserved cadavers, as well as dissections of freshly removed larynxes.

Bilateral abductor paralysis is most commonly the result of injury to both recurrent laryngeal nerves during a thyroidectomy. All the muscles of the larynx are paralyzed except the cricothyroid. The fibers of this paired muscle are attached to the inner surface of the lower part of the thyroid cartilage, pass obliquely downward and forward to insert on the anterior surface of the cricoid cartilage. Contraction tends to pull the cricoid cartilage backward and the thyroid cartilage forward thus increasing the anteroposterior diameter of the voice box and tensing the vocal cords. The muscle is supplied by a branch of the superior laryngeal nerve which passes from above downward along the external surface of the thyroid lamina deep to the thyrohyoid and sternothyroid muscles. Usually, immediately following a paralysis of both recurrent laryngeal nerves, the vocal cord assumes an elliptical or cadaveric position allowing space for breathing, but not enough apposition for good voice production. The cords are more or less flaccid but as time passes the unopposed action of the cricothyroid muscle produces more and more adduction until finally the voice becomes nearly perfect but breathing is impossible. Many months or many years may elapse before the increasing obstruction necessitates a tracheotomy. Some patients with bilateral paralysis carry on for years with a hoarse voice but a fairly adequate breathing space. For such, no treatment is recommended.

When obstructive dyspnea becomes disabling and no tracheotomy has been previously performed, it must be done as a preliminary step in the King operation. Under a local anesthesia a tracheotomy tube is inserted as low down on the trachea as exposure will allow. The second operation is performed as soon as the tracheotomy wound is well healed and the patient has become accustomed to the tube—a matter of four to six weeks.

For anesthesia King recommends sodium pentobarbital intravenously. Inhalation narcosis would be difficult and local anesthesia would not abolish movements of the throat and larynx. It is well to drape the patient so that the entire neck is visible and the chin, the angle of the jaw, the mastoid bone, the sternomastoid muscle, the thyroid notch, and the suprasternal notch, are either visible or easily palpable. If care is used the tracheotomy tube can remain uncovered in the field. A wisp of cotton over the opening may help the anesthetist in watching respirations if intravenous anesthesia is employed. King isolates the tube by placing a small tea-strainer over it to support the sterile drapes.

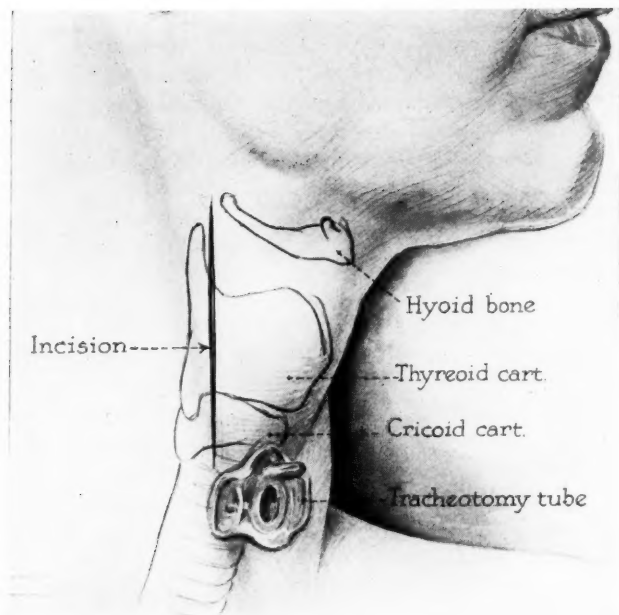


Fig. 1.

The incision extends from the level of the hyoid bone above to that of the cricoid cartilage below (Fig. 1). The lower end will probably reach to the level of the tracheotomy tube. It is placed along the anterior border of the sternocleidomastoid muscle. Exposure is better if the upper portion is placed medial to the anterior border of the sternomastoid so that the incision is more nearly parallel to the longitudinal axis. It passes through skin, fat, superficial fascia, and platysma. The skin flaps are freed widely by knife dissection at a level between the platysma and the superficial layer of the deep fascia. A vigorous pull on sharp cats-paw retractors placed on the skin edge aid in this maneuver. As a rule, most of the technical difficulty encountered in neck operations is due to a failure to raise adequate skin flaps. This operation is no exception.

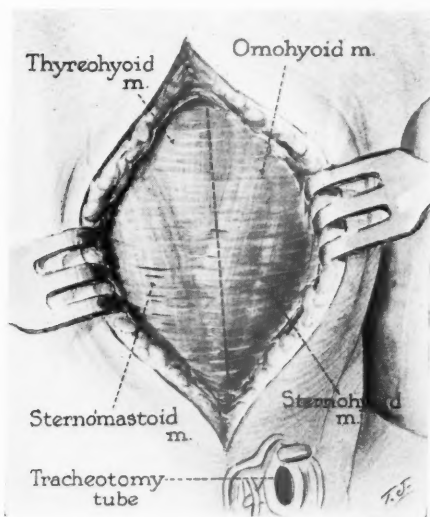


Fig. 2.

The surface of the wound consists of a thinned out sheet of the superficial layer of the deep fascia (Fig. 2). The omohyoid muscle passes obliquely across the inner half. It must be remembered that the head is turned sharply to one side and consequently the omohyoid will be found in a much more medial position than one expects. The sternohyoid muscle is medial to the omohyoid; the thyrohyoid is at a deeper level above and laterally. The border of the sternomastoid is clearly visible the entire length of the wound. An incision through the deep fascia gives access to the deeper structures. Again, better exposure is obtained if it angles away from the anterior border of the sternomastoid. The omohyoid muscle is freed and severed high up near the hyoid bone. King attaches the cut end to the arytenoid cartilage. For reasons to be discussed later, this step has been omitted. If one intends to transpose the muscle it should not be freed along the lateral border for, as King has pointed out, this would sever its nerve supply. If one does not intend to transpose the muscle it must be severed anyway in order to facilitate exposure.

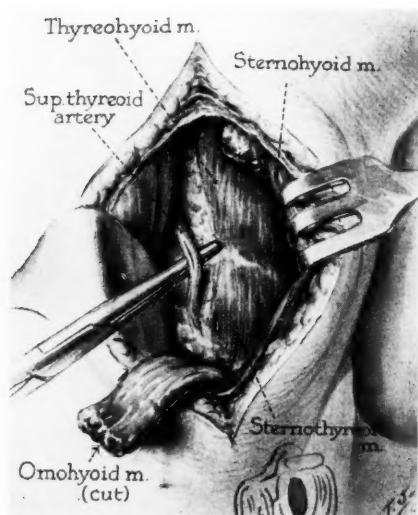


Fig. 3.

After the omohyoid is severed, retractors are placed beneath the border of the sternohyoid muscle medially, and the sternomastoid laterally (Fig. 3). Then one can see the thyrohyoid and sternothyroid muscles and their common attachment to the ridge on the lateral surface of the thyroid cartilage. In the lower angle of the wound is the scar tissue resulting from the ligation of the superior thyroid vessels during the previous thyroidectomy. If the ligation is low, the upper pole of the thyroid gland itself is visible. The superior thyroid vessels lying in the depth of the wound are carefully isolated, divided, and ligated. During this procedure, the common carotid artery and the jugular vein are freed and retracted laterally.

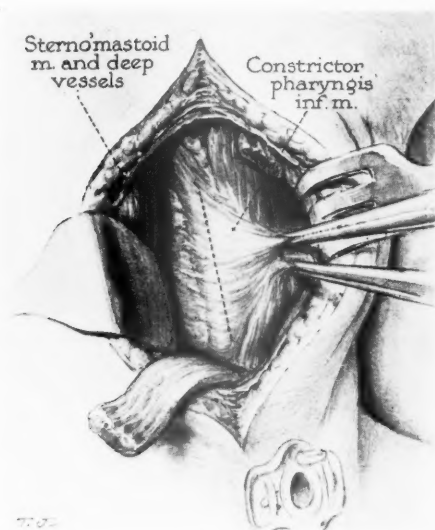


Fig. 4.

The larynx is rotated sharply by pressure of the fingers from behind, and held in that position by one or more hemostats clamped to the fascia or fibers of the sternothyroid and thyrohyoid muscles where they attach to the cartilage (Fig. 4). The posterior border of the laryngeal cartilage can easily be palpated from its superior to its inferior horn. The muscle fibers of the inferior constrictor of the pharynx are easily recognized as they curve around the posterior border of the laryngeal cartilage. An incision is made through the inferior constrictor a few millimeters from the posterior border of the cartilage for almost the entire length of the cartilaginous border. If the incision is placed too far medial on the cartilaginous plate, it may reach medial to the origin of the inferior constrictor. Unnecessary difficulty would be encountered in freeing the muscle.



Fig. 5.

The inferior constrictor is easily separated from the anterior surface of the cartilage (Fig. 5). The underlying mucosa is then carefully separated from the posterior surface of the cartilage. The mucosa folds in behind the cartilage as shown in Fig. 8. It is attached by a few fine fibers to the very edge of the cartilage and can be rather easily separated by snipping a few of these fibers and pushing the mucosa back with the handle of a scalpel. Then the muscular fibers of the cricoarytenoideus posticus come into view in the lower part of the field. Because of the rotation of the larynx they are directed obliquely upward and transversely.

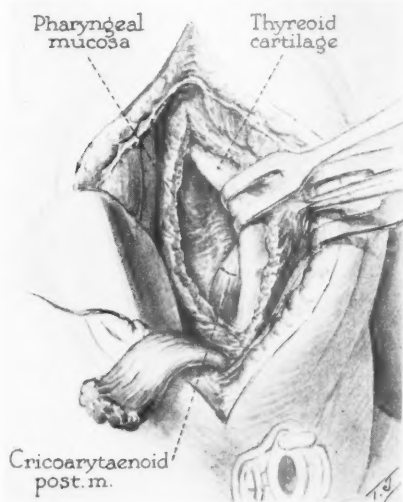


Fig. 6.

A small curved retractor is placed over the edge of the cartilage in order to rotate the larynx, which is turned almost a full 90 degrees (Fig. 6). For this purpose King recommends the eyelid retractor used by the ophthalmologist. As the muscular fibers of the cricoarytenoid muscle turn inward, cross the joint, and attach to the base of the arytenoid cartilage, they become tendinous in character. At this point the musculotendinous bundle is severed transversely.

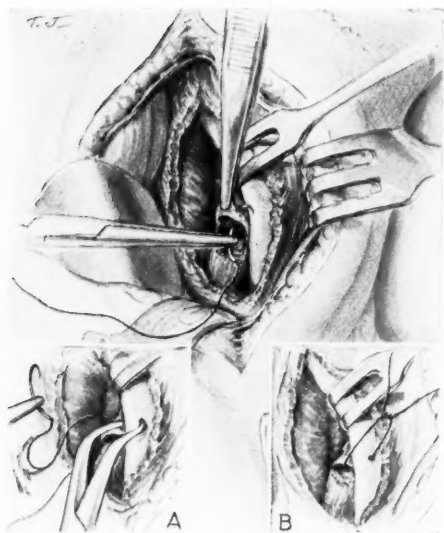


Fig. 7.

The severed attachment of the muscle is grasped by a dissecting forcep and the joint capsule found by a few exploratory cuts with a small pointed scissors (Fig. 7). The joint is opened widely and the cartilage freed of the attachment of the crycoarytenoideus lateralis muscle along its anterior border and of the interarytenoideus along the posterior border. The upward prolongation of the body of the arytenoid cartilage can also be cleared of fibers of the interarytenoideus. While the cartilage is held firm, a small cutting needle (a cleft palate needle carrying a fine chromicized catgut) is passed from within out, through the anterior border of the vocal process of the cartilage. The suture must pull on the vocal process. To place it far enough anteriorly one may have to remove a segment of the border of the thyroid cartilage. Care must be used, chiefly in steadying the cartilage or it may be torn or fractured by the needle. This suture is then passed through the lamina of the laryngeal cartilage at the level of the joint and tied there. A towel clip easily pierces a hole through the cartilage to facilitate the passage of the needle. This entire maneuver can be performed more easily in an operation on the right arytenoid than on the left one. Before the

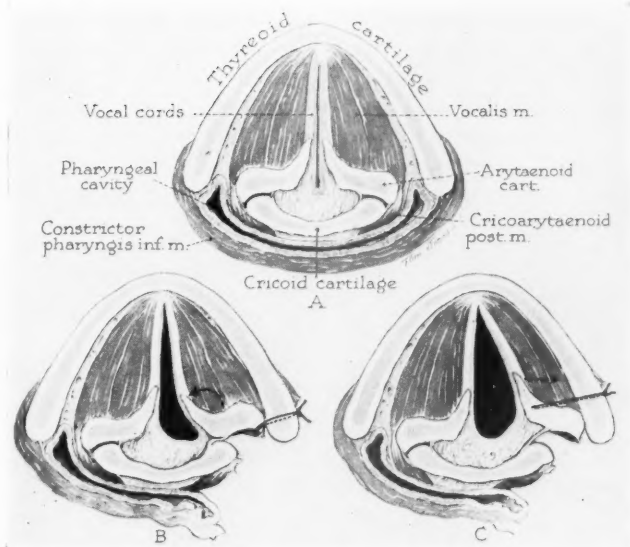


Fig. 8.

suture is tied the vocal cords should be visualized by direct laryngoscopy. If the opening has not been widened adequately, the suture will have to be replaced. This is an important step. King places this suture in a different manner. The needle is passed behind the body of the arytenoid, either passing through it or encircling it, coming out laterally at the vocal process. A large knot is made in the strand of catgut so that it impinges on the vocal process when an attempt is made to pull the catgut through. It can be seen that such action will certainly rotate the vocal process in an outward direction.

The size of the breathing space that will be obtained depends almost entirely upon the proper placing of the suture through the arytenoid cartilage (Fig. 8A). It would seem that this step alone determines the success or failure of the entire operation. In cross section, just above the level of the joint, the arytenoid cartilage has a crescentic shape. The anterior limb of the crescent, the processus vocalis, to which the vocal cord is attached forms an angle of 30 degrees with the larger posterior limb, the processus muscularis, to

which is attached the principal muscles that move the vocal cords. The only abductor, the cricoarytenoideus posterior, has its origin from the posterior surface of the cricoid cartilage; its fibers are directed upward and laterally to insert on the posterior aspect of the muscular process of the arytenoid cartilage. Contraction of its fibers produce a rotation of the arytenoid cartilage, clockwise on the right side, anticlockwise on the left. The tip of the processus vocalis and its attached vocal cord rotates laterally; the muscular process of the cartilage rotates toward the midline.

It must be remembered that the arytenoid cartilage as a whole does not move in a lateral or medial direction in any of the movements of the larynx. Movements of the vocal cords are caused solely by a rotation of the cartilage.

Adduction of the vocal cords is produced largely by contraction of lateral cricoarytenoideus muscle. The fibers of this muscle arise from the posterior surface of the anterior arc of the cricoid cartilage, pass directly backward to insert on the anterior part of the processus muscularis of the arytenoid.

If one were to place a suture through the processus muscularis of the right arytenoid cartilage, and attach it laterally to the thyroid cartilage, he would move the entire arytenoid cartilage outward only a millimeter or two. At the same time, however, since the internal capsule of the joint is intact and acts as a fulcrum, the cartilage will be rotated anticlockwise, bringing the vocal cord in a more adducted position. If, on the other hand, he places the suture more anteriorly through the processus vocalis and then sutures it to the thyroid cartilage, a clockwise rotation is produced resulting in a fairly wide abduction of the vocal cords. Fig. 8B represents the movement of the cartilage and the shape of the vocal slit when a suture is passed through the processus muscularis of the arytenoid cartilage and attached to the thyroid cartilage. The cartilage is pulled laterally widening the vocal slit in only its posterior part; the tip of the vocal process of the arytenoid cartilage is turned inward. By rearranging the suture one can make the condition one wishes to cure worse rather than better.

Galloway³ has attacked the arytenoid cartilage from another direction. He has cut a window directly through the plate of the thyroid cartilage and then sutured the vocal process of the arytenoid in outward rotation. Through this approach he comes down directly upon that part of the arytenoid that one must utilize. In addition, he has obviated the dangers of infection for, even though the larynx

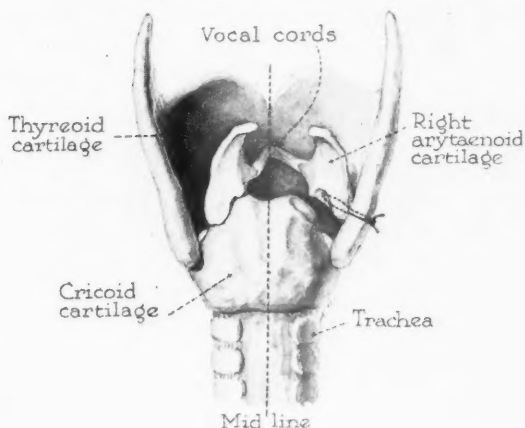


Fig. 9.

were opened from this approach, it would be unlikely that much harm would ensue. His operation seems more simple of performance and does accomplish the same end result; namely, fixed abduction without intralaryngeal scarring.

The suture has been placed more anteriorly, the cartilage is rotated in a clockwise direction, and there is wide abduction of the vocal cord (Fig. 8C). This maneuver causes the processus muscularis to move toward the midline away from the thyroid cartilage rather than toward it. In performing the operation, it is technically easier to pass a suture through the posterior portion of the cartilage (the processus muscularis) rather than through the anterior portion, and if one does not understand that he is attempting to rotate rather than abduct the cartilage, he may do so. To verify these points we have dissected fresh specimens and placed strings through all portions of the cartilage, pulled in various directions, and attached them to the thyroid cartilage in various positions. In the cadaver, one can obtain the maximum degree of abduction of the vocal cord merely by reefing the muscular fibers of the cricoarytenoideus posterior. The muscle can be reefed and shortened easily in the cadaver, maintaining any degree of fixed abduction that one wishes. Whether the sutures would hold in a living patient, I do not know.

Fig. 9 shows the relation of the cartilaginous parts of the larynx, the shape of the arytenoid cartilage, and a reconstruction of what occurs when the arytenoid is sutured to the thyroid cartilage.

DISCUSSION

In King's original description of his operation, the omohyoid muscle is attached to the processus muscularis of the arytenoid to serve as a tendon transplant. This step, though it may be useful, was omitted because of his conclusions in his second paper in which he made the following statements:

"When I first worked out the theory of this operation, it was based upon the idea that the cord to which the omohyoid muscle was transposed would develop all the motion and that the opposite cord would remain fixed in the midline. Facts have not sustained that theory. The facts are that the operated cord remains silent or inactive while the opposing cord moves inward on phonation and outward on inspiration.

"Repeated examinations of these patients seem to warrant the conclusion that the opening and closing of the cords is chiefly effected by changes in the anteroposterior diameter of the larynx. The alterations in that diameter are produced altogether by the cricothyroid muscles."

In other words it would seem that the operation is basically an arthrodesis of the arytenoid joint with the arytenoid fixed in abduction and external rotation, rather than an arthroplasty with a tendon transplant.

Although the operation is not a formidable one, it is a meticulous procedure. In conclusion it is well to repeat King's admonition: "No one should undertake this operation without first acquiring an accurate knowledge of the anatomy involved. I suggest that anyone who wishes to undertake it first go to an anatomic laboratory and do it, not once, but several times."

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V

OSTEOMA OF THE MAXILLARY SINUS*

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AND

LAWRENCE R. BOIES, M.D.

MINNEAPOLIS

This paper presents reports of two extensive osseous maxillary tumors conservatively treated. Only a few such cases have been reported and the treatment of these two cases was contrary to the radical surgical therapy often advocated.

Osteomas of the paranasal sinuses and cranium are not common. They have been recognized in the frontal bone since ancient times. One report dates from 1791.²¹ They occur in animals as well as in man. An elk skull, found in Newfoundland, showed a huge bony tumor which was thought to have pressed on the animal's brain causing death.¹¹ A specimen from an ox measuring eight and one-half inches in diameter and weighing over 16 pounds has been described.²⁸

The total number of human cases said to have been reported varies with different authors.^{3, 8, 14, 22, 31, 32} Up to 1927 only 277 cases involving all sinuses had been reported, according to Sjöberg.³² He found reports of 66 more from 1927 to 1934. Six of these involved the maxillary sinus. The Sabbatsberg Oto-Laryngological Clinic in Stockholm registered 34,226 patients in twenty-five years. Osteoma of the maxillary sinus was diagnosed twice in this large group.

Childrey⁸ believes sinus osteomas are unusual but not rare. He feels that many small osteomas are undiagnosed because they produce no symptoms, and that case reports deal mainly with tumors large enough to involve adjacent structures. Childrey made the diagnosis fifteen times in eight years. Two of his patients had involvement of the maxillary sinus. Handousa,²¹ reporting from Cairo, Egypt, saw eighteen osteomas in seven years. All were definitely

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attached to the frontal bone. Carmody⁷ states that the maxillary sinus was formerly believed to be most often involved, but that later writers agreed that frontal osteoma is most common. In 1865 Paget²⁸ said: "The most frequent seat of these tumors is the frontal bone." The infrequent surgical exploration of the frontal bone is thought to explain the earlier view.³⁵

Bell⁵ mentions having seen two children in whom the body of one maxilla was slightly enlarged and the entire bone including the antrum was completely replaced by a solid tumor. The structure was that of osteofibroma. The literature dealing with osteoma of the maxillary sinus was reviewed by Rawlins in 1938.³¹ He summarized twenty-seven reported cases of maxillary sinus osteoma with the report of his own two cases.

The tumors usually grouped under the name osteoma are not all true osteomas, which are composed of dense bone and have a limited growth.⁵ Histologically most paranasal sinus osteomas contain fibrous tissue separating spicules of bone. The more rapidly growing osteomas are mainly fibrous.¹⁹ Fetissof¹⁴ described them as eburnated, spongy, and mixed.

Several explanations of the formation of these tumors have been advanced. Virchow³⁶ believed they arose from the diploe of bone. Cloquet¹⁰ thought osteomas to be ossified polypi. These theories are dismissed by Fetissof¹⁴ as archaic. At present two main theories attempt to explain the origin of these tumors. One school believes cartilaginous rests give origin to osteomas. A second group holds that osteomas are formed by ossification of fibrous tissue laid down during the normal healing process.

Arnold¹ thought osteomas arose from cartilaginous rests. According to Cohnheim's theory,⁴ since the ethmoid was developed from cartilage and the frontal from membrane, tumors ought to arise frequently at their line of union. Childrey⁸ said: "A true osteoma is a circumscribed bony growth of spontaneous or traumatic noninflammatory origin. It is derived from cartilage and formed by osteoblasts." He continued later: "Fragments of cartilage connected with the ethmoid cells give rise to most of the osteomas of the frontal and maxillary sinuses. The fact that such embryonic cartilaginous rests have not been demonstrated may be disregarded, for not many osteomas have been studied with this purpose in view." Evidence to prove the existence of cartilage in the maxilla in its embryologic stages exists. Membranous ossification is said to pro-

ceed from three centers to include a cartilaginous mass which develops in the malar process.¹³

The opinions of several authors who hold that osteomas arise from fibrous tissue metaplasia are summarized below. Fetissof¹¹ examined four osteomas histologically. He concluded that osteoblasts played little part in the formation of osteomas, but that the bone is mainly formed by metaplasia of connective tissue. He thought the spongiöse parts of an osteoma should be considered the younger parts. He believed that his histologic sections clearly showed the connective tissue merging into bone without a perceptible demarcating zone.

Eden¹² believes these tumors are "produced by the transformation of fibrous tissue directly into bone by metaplasia." He believes that fibrous overgrowth of the periosteum occurs, or that the bone marrow is replaced by fibrous tissue which later erodes the old bone. New bone then forms directly in the fibrous tissue by metaplasia.

Geschickter and Copeland²⁰ regard this process as the normal healing reaction of bone. They regard giant-cell bone tumor and localized osteitis fibrosa as opposite extremes of a single process. They point out that both of these conditions are found, not only in the vicinity of disease foci, but also in relation to temporary structures in bone, such as the epiphyseal cartilages of long bones and the deciduous teeth, where the process of resorption and healing of bone are proceeding normally.

Rawlins³¹ believed that a history of injury has been reported too often to be coincidental. He dismissed the fetal cartilage theory as not explaining osteomas whose pedicles arise from bones not laid down in embryonic cartilage. Smith³³ considered that in some cases the "essential primary process is one of healing or repair with new bone formation, and the sequence of events in some cases would be: trauma, giant cell tumor, bone cyst, osteitis fibrosa, fibroma." He supported his contention by histologic data on six cases. Expositions of this controversial subject include the studies of Fetissof,¹¹ Childrey,⁸ Smith,³³ Phemister and Grimson,³⁰ Eden,¹² and Geschickter and Copeland.²⁰

Small osteomas producing no symptoms may be accidental radiologic findings. Larger ones often are first noticed when they encroach on adjacent structures. Probably the most important diagnostic aids are roentgenography²⁹ and biopsy.

In the maxilla several tumors occur more frequently than osteomas. These must be considered in the differential diagnosis. Some are of dental origin; others originate from the maxilla or its investing

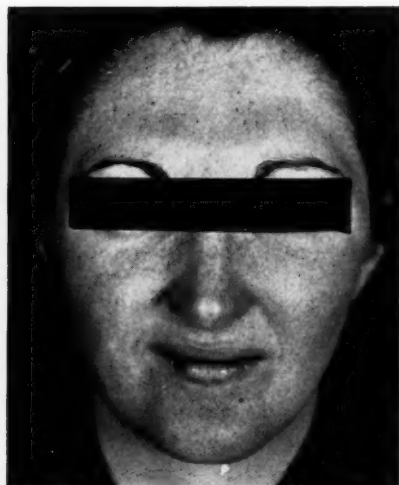


Fig. 1.—Photograph of patient in Case 1 twelve years after diagnosis of osteofibroma of left upper jaw.

membranes. Epithelium of adjacent sinuses or the nose gives rise to invasive lesions. Local manifestations of general diseases of bone may simulate primary tumors.

No classification of epithelial cysts of the jaws has been generally accepted.²⁰ One classification of the tumors arising from dental cells has been made by a committee of the British Dental Association.³⁸ The epithelial odontoma group comprises the dentocystic tumors. These are: (1) dental or root cysts, (2) dentigerous or follicular cysts, and (3) adamantinomas or multilocular cysts. The writings of Figi,¹⁵ Ivy,²⁶ Waldson,^{38, 39} and Geschickter and Copeland²⁰ form the basis for the following discussion of tumors of dental origin.

Root cysts develop at the chronically infected root ends of erupted deciduous or permanent teeth. Their clinical course of bone destruction and sinus involvement puts them into the category of neoplastic lesions. Root cysts push up the floor of the maxillary sinus until its cavity may be obliterated. Often there is no communication with the sinus. The sinus lining folds upon itself, leaving a very small space through which the secretion can seep. The tooth giving origin to the cyst may have been extracted, after which the cyst has continued to grow. The cyst may overlie the apices of

several teeth, in which case careful tests must be made to incriminate the proper tooth. A fistula may lead into the cyst from the mouth.

Dentigerous cysts develop about the crowns of completely or partially formed unerupted teeth. Microscopic examination of dentigerous cyst walls show some of them to be potential adamantinomas. The dentigerous cyst takes its name from the fact that it bears a tooth. The cyst cavity contains straw-colored fluid. The crown of a partially or fully developed tooth projects into it. These cysts are usually first noticed about the time of permanent tooth eruption. Any tooth may be involved, but most commonly it is the canine, next the third molar. A supernumerary tooth may connect with the cyst.

The adamantinomas or adamantine epitheliomas are multilocular, cystic tumors in the group of cystic odontomas. They apparently originate from enamel organ cells. They occur chiefly in the third and fourth decades and are more often seen in males than females. They are partly cellular and partly cystic in varying proportions. The cellular and cystic areas are separated by bony trabeculae. They therefore have irregular, honey-combed surfaces. The X-ray gives a fairly characteristic appearance because of these structural peculiarities.

Conglomerate disordered masses of enamel, dentine, and cementum originating in the dental epithelium are not uncommonly found. They occur at all ages. They may be undiscovered until infection supervenes. They are then sometimes mistaken for necrotic bone as part of osteomyelitis. Histologically they are classified according to the predominant type of tissue.

Torus palatinus is an ovoid eminence on the hard palate, usually in the midline. Histologically it is composed of dense bone. It is usually smooth but occasionally nodular. It is sometimes mistaken for a malignant lesion. Most persons are unaware of such growths unless dentures irritate them or they are noticed during examination.

The term "mixed tumor" applies to the most common salivary gland tumor. It occurs most often in the parotid gland. It is also found in the lips, cheeks, palate, pharynx, nasal cavities, and lachrymal gland. The growth develops slowly, usually having been noticed several years before operation is performed.⁶

Nasopalatine cysts are described by Ivy²⁶ as arising in the maxilla from the epithelial remnants of the nasopalatine duct. Such a



Fig. 2.—Photomicrograph (x150) of tissue from Case 1, showing fibrous tissue separating bone spicules.



Fig. 3.—Roentgenograph of Case 1 twelve years after diagnosis, showing replacement of part of antrum cavity by bone together with thickening of maxillary wall.

cyst may present a swelling on the hard palate in the interincisive region. Small ones may be accidental roentgenographic findings. These cysts occasionally became secondarily infected and discharge pus into the mouth.

The term "epulis" is given to circumscribed tumors having narrow pedicles rising from the alveolar ridge at the gingival margins of the teeth and spreading over the gum surface, often displacing or covering teeth. Because the term epulis is indicative only of region and not of histologic structure, tumors of extremely variable histology are thus named. Epulides are usually of three main types: fibroma, fibroangioma, and benign giant-cell tumors. Ivy²⁶ believes that the term "giant-cell sarcoma", formerly applied to the last-named group, is an unfortunate misnomer. It implies malignancy and thus dictates more radical treatment than this benign lesion needs.

Metastatic tumors of the jaw bones are rare. Cases of carcinoma of breast, thyroid, rectum, ovary, prostate, and others are on record.^{18, 19, 28}

Malignant tumors of the antrum of Highmore must be ruled out when a tumor of the maxilla is being considered. The rapid growth, pain, rarefaction of bone, with characteristic roentgenographic findings, the accompanying cachexia, together with its usual occurrence in older people, are cardinal features. Loosening of teeth may be the first symptom.²⁰ If the usual diagnostic methods do not settle the question of malignancy, exploration of the antrum should be carried out. New²⁷ believes this is best done after preparations for complete removal of the potentially malignant lesion have been made. He prefers to have a frozen section of the tumor examined, and if malignancy is present, to proceed with the removal immediately. One can then accurately delineate the tumor, he thinks, because the edema and reaction to previous investigative trauma are not present.

Lesions in the maxilla may be found in Paget's disease of bone (osteitis deformans). These are reported by Stafne and Austin³¹ as giving characteristic roentgenographic findings in dental films. The presence of generalized Paget's disease would aid in diagnosis. Biopsy might be necessary for final diagnosis.

The giant-cell tumors found in osteitis fibrosa cystica (von Recklinghausen's disease of bone) may first appear on the upper jaw.^{20, 39} In Barr and Bulger's² second case a painless swelling of

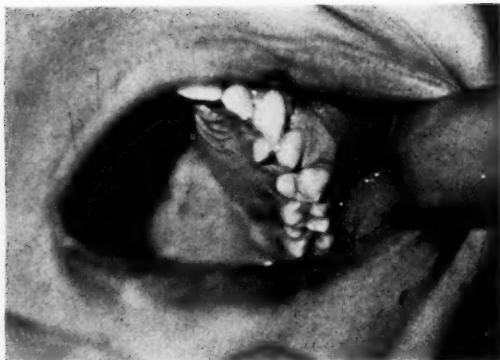


Fig. 4.—Photograph of patient in Case 2, showing deformities of maxilla medial and lateral to alveolar ridge.

the left upper jaw was present for eight months before the patient's admission to the hospital. The lesion proved to be one of several giant-cell tumors. A diagnosis of parathyroid tumor was made six weeks later. After removal the mouth healed and the giant-cell tumors did not recur. Wilder³⁹ described a similar case in which a giant-cell tumor of the upper jaw was among the presenting symptoms. In both cases the authors pointed out that failure to consider a diagnosis of hyperparathyroidism resulted in radical treatment of a nonmalignant upper jaw lesion. Blood chemistry may indicate the presence of deranged calcium metabolism should biopsy reveal giant-cell tumor.

Occasionally these tumors have been observed to slough off. In pre-aseptic times physicians attempted to imitate this spontaneous therapy by "exposure of the tumor and application, if need be, of escharotics to the surface of the bone".²⁸ Surgical treatment was sometimes fatal, as the tabulation of cases in Rawlins³¹ paper illustrates.

Many authors believe the treatment ought to be surgical. Rawlins³¹ said that "operation should be carried out as soon as the diagnosis is made". Gatewood and Settel¹⁸ favored operative removal. Carmody⁷ believed surgical treatment was undoubtedly best. Garretson¹⁷ advised "complete surgical removal whenever possible." Perlberg and Kruger,²⁹ in discussing cranial osteomas, said the tu-

mors should be removed even though the patient is asymptomatic, for fear that ultimately the slow growth would encroach on important structures.

Some authors have expressed more conservative opinions. Handousa²¹ believed that symptomless osteomas in adults can be safely let alone. He did not believe that they are likely to grow larger later and thus give symptoms, or that they become sarcomatous.

Hempstead²³ said that small asymptomatic osteomas should be "re-examined subsequently at periodic intervals and if any evidence of growth appears, should be removed." Childrey⁸ questioned the necessity for advising surgical excision on all osteomas. He believed many osteomas must have existed without symptoms or treatment. Friedberg,¹⁶ in discussing osteoma of the mastoid, said he thought removal was only justified if the tumor caused distressing symptoms, or for cosmetic reasons. Phemister and Grimson³⁰ believed that in view of the benign nature of the lesion, massive resections are often not justified since they carry a high mortality rate and are disfiguring. They thought biopsy was essential in deciding on the proper mode of treatment. Sjöberg³² thought operation ought to be done if "clinical complication symptoms were present".

The paper of Phemister and Grimson³⁰ is the only one reviewed which mentions the use of radiation therapy. Six of their thirteen cases of fibrous osteomas received roentgen therapy. They said: "The experience in treatment of these patients makes it appear that roentgen therapy is beneficial in controlling portions of the tumor not removed at operation."

Eden¹² believes the "treatment of these tumors is essentially conservative, and should be directed toward the prevention or cure of definite symptoms, rather than radical excision." Among his cases are several exactly similar to ours. One man had gone ten years after the diagnosis was made. His tumor had enlarged slightly, but surely radical excision would not have been justified. Geschickter and Copeland²⁰ favor conservative therapy.

Our two cases have been treated only by roentgen therapy. The diagnosis was established in each case by biopsy. Both were of the spongiöse type of osteoma. Each involved the maxillary sinus and had expanded enough to disfigure the patient's face. Each ceased to grow soon after treatment. We recognize that other factors than the radiation may have caused the cessation of growth. These tumors are known to start in childhood and have a tendency to stop grow-

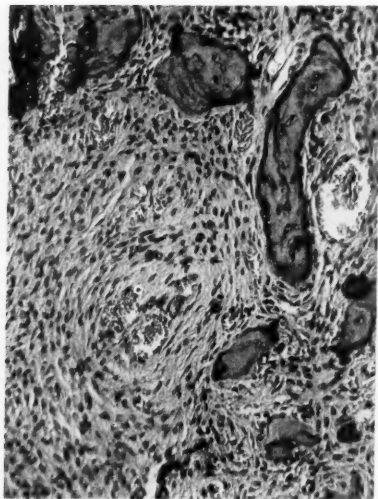


Fig. 5.—Photomicrograph (x150) of tissue from Case 2, showing bone islands separated by somewhat cellular fibrous tissue.



Fig. 6.—Showing facial deformity in patient of Case 2.

ing in adult life. One of the patients has now gone twelve years since therapy and is well. The second patient has gone two and one-half years.

Because conservative therapy seems to have averted disfiguration and dangerous surgery for these patients, their cases are being reported. We do not draw general conclusions from these two instances. We present them as examples of apparently successful non-surgical treatment of a lesion often treated by radical surgery.

CASE REPORTS

CASE 1.—(U. H. No. 585948.) White female, aged 14 years, during a dental examination in 1929, was found to have a swelling on left upper jaw. The swelling had not been painful. The patient was unaware of its presence. Six weeks later the patient was first seen at the University Hospital.

Examination revealed a smooth, hard outgrowth on the lateral surface of the left maxilla above the teeth. There was diffuse enlargement of the left cheek. Roentgenography revealed a dense bony mass encroaching upon the left maxillary sinus cavity. A tentative diagnosis of osteogenic sarcoma was made. Biopsy was not done and 125 per cent skin erythema dose of deep roentgen therapy was given in three treatments over six days in October, 1929.

The patient returned to the hospital in March, 1930. The tumor had increased slightly in size during the eighteen-month interval, but did not trouble the patient. A biopsy showed the tumor to be an osteofibroma (Fig. 2). In two treatments over three days 115 per cent skin erythema dose of roentgen therapy was given over the left antrum.

The patient was re-examined in 1941. The mass had changed little during the twelve-year interval. The radiologist commented that "the appearance is typical of what is described as a sclerosing fibroma of bone, which does not appear to be progressing" (Fig. 3).

The patient is a graduate nurse and carries on her work without symptoms from the tumor. Her appearance in 1941 is shown in Fig. 1.

CASE 2.—R. S. (U. H. No. 691146), white female, aged 19 years, was in an automobile accident in August, 1937. The left side of her face was bruised very badly. The swelling receded after one week. From then on the patient could feel a mass "on her left cheekbone." No pain or growth was noticed until the summer of 1939, when, two years after the injury, she noticed that the left cheek was softer than the right one. The tumor increased in size slowly. Three or four weeks before her first visit at the University Hospital pain in the cheek was first noticed.

The appearance of the patient when she was first examined is shown in Figs. 4, 6, and 7. A nodular, hard mass protruded from the external surface of the left maxilla, palpable as a diffuse enlargement of the cheek. The orbital rim was smooth and uninvolved. A mass extended downward, medial and lateral to the alveolar process as shown in Fig. 4.



Fig. 7.—Showing facial deformity in patient of Case 2.

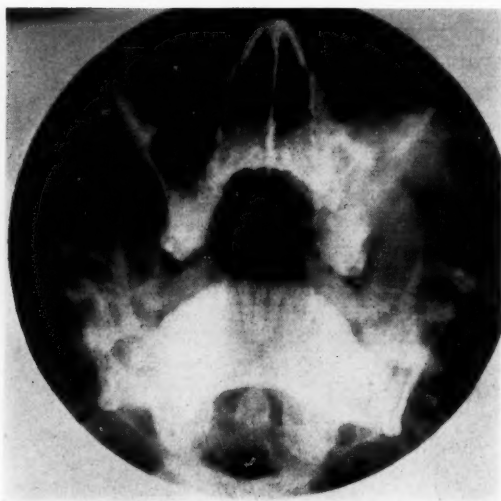


Fig. 8.—Roentgenograph of Case 2 showing dense mass replacing left antrum.

Roentgenography demonstrated a very dense mass filling the left maxillary sinus but not extending into the nose or orbit (Fig. 8). The roentgenologist thought the tumor was "probably a benign osteoma arising in the left maxillary sinus."

Tissue for histologic study was obtained through a left canine fossa incision. It was removed with a gouge from the mass above the alveolar margin. Fig. 5 shows its structure. Multiple irregular bone spicules were distributed through a dense fibrocellular stroma.

Because of the experience with Case 1, and the reports of successful conservative management in the literature, surgery was not done. Roentgen therapy was given. Through the anterior surface of the cheek 1,910 tissue roentgens were given, and 2,000 tissue roentgens through the lateral side of the left cheek.

The patient has been examined frequently. There is no evidence of further growth. The patient has been under observation for two and one-half years.

1008 MEDICAL ARTS BLDG.

1631 MEDICAL ARTS BLDG.

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VI

COMPLETE CICATRICAL STENOSIS OF THE ESOPHAGUS: PERMEATION MADE POSSIBLE BY EXTERNAL OPERATION IN CERTAIN CASES*†

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Cicatricial stenosis of the esophagus is frequently encountered. Usually it is the result of the accidental ingestion of lye by children. Many other cases in adults are the result of the ingestion of alkalis or acids, either swallowed accidentally or in an attempt at suicide; and occasionally it is encountered as a result of ulceration from various other causes, such as peptic ulcer, foreign body, or other inflammatory lesions.

The long fight led by Chevalier Jackson to secure the proper labels on lye containers is now bearing fruit, for these tragic cases are not seen as frequently now as in past years.

Fortunately complete stenosis seldom occurs. In our study of fifty-two strictures encountered in forty-six patients, only two patients presented an impermeable stricture, one due to the accidental ingestion of lye by a child, and one due to an attempt at suicide by an adult who had swallowed a large amount of lye. In this latter case, the stricture involved the major part of the esophagus.

In reviewing our records, it was interesting to note the sites of the strictures. In the group of those who had accidentally ingested lye, approximately 53 per cent were in the upper third, 24 per cent in the middle third, and 24 per cent in the lower third of the esophagus. In the group of those who had attempted suicide, approximately 14 per cent were in the upper third, 71 per cent in the middle third, and 14 per cent in the lower third.

The figures seem to indicate that the prompt recognition and expectoration of the offending material limit the inflammatory reaction to the upper third of the esophagus in the majority of instances

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†Read before the American Academy of Ophthalmology and Otolaryngology, Chicago, Oct. 23, 1941.

in the accident group; whereas, in the attempted suicide group, since a larger amount of the offending material is deliberately swallowed, the reaction can be expected to be further down the esophagus and to be more severe in nature.

It is fortunate that the majority of the strictures in the accident group occur in the upper third, since this is the part of the esophagus most accessible to external surgical approach in case of complete stenosis, and also because this is the group we are most anxious to rehabilitate. However, any portion of the esophagus is now accessible to the thoracic surgeon, and the method we are advocating can be applied in any instance.

The treatment routine as recommended and followed by us is briefly as follows: The emergency treatment of the acute case is the prompt lavage of the face, mouth, esophagus, and stomach with the proper neutralizing solution such as vinegar, dilute acetic acid, or bicarbonate of soda. Then a rubber feeding tube is inserted through the nose to the stomach, and left in place for from ten to 14 days; and we feel reasonably certain that several strictures have been avoided by this procedure.

The esophagus is not studied either by the roentgen ray or the esophagoscope under three weeks or longer. If there is a beginning stricture, careful and gentle bouginage is carried out from time to time through the esophagoscope.

The majority of the patients present themselves for treatment from two to four months after the ingestion of the offending material, because of increasing difficulty in swallowing, pain on swallowing, and loss of weight. They are first sent to the department of radiology for fluoroscopic examination with an opaque meal and films for study and records. They are next examined with the esophagoscope, and if the stricture is slight or moderate, dilatation is carried out with Jackson flexible bougies under vision at increasing intervals.

When the stricture is marked, the patient is referred directly to the department of surgery for a two-stage gastrostomy. There should be no hesitancy in doing this, for the sooner proper food and fluids can be given, the more quickly active treatment can be started. Gastrostomy should be done with due consideration as to its type and location for future retrograde bouginage.

When the gastrostomy has healed, an attempt is made to have the patient swallow a string. In most instances, this is readily ac-



Fig. 1. Case 1.—Thread-like stricture 2 cm. long in the upper third, on admission.

complished, and the free end is fished from the stomach through the gastrostomy opening, the upper end is brought out through the nose, and the two ends are knotted on the outside.

When the string is once in place, future treatment is carried out by the retrograde method of Dr. Gabriel Tucker, fully described by him in numerous articles.

Since so many of these patients are indigent, they are discharged from the hospital as soon as possible, and dilatation is carried out in the out-patient department. When treatment is well established, many return to their home physicians for further dilatation. In some instances, mothers and nurses are instructed in the technic and carry out the treatment very well, for under the Tucker method, dilatation is so safe and easy that many small patients actually pull the bougies through themselves. The patients return from time to time for check-up at the clinic and further instructions as to the sizes of bougies to be used. We have found that treatment for about two years is necessary before the gastrostoma can be safely closed, and even then an occasional per oral dilatation may be necessary.

While the passage of a string is usually accomplished without difficulty, at times it calls for great ingenuity and patience. Among the procedures used are the passage of radiopaque ureteral bougies through the nose or mouth or through the esophagoscope; in other instances, the ureteral or Jackson bougie is passed from the stomach by retrograde esophagoscopy. To find the lower end of the esophagus is not always easy. We have used the cystoscope and gastroscope as well as the short esophagoscope. The latter is by far the instrument of choice. The characteristic change in the color of the mucosa noted when entering the stomach through the esophagus is not noted here, and the best sign of having entered the esophagus that we have noted is the marked cardiac impulse transmitted to the tip of the tube. When the esophageal lumen is still patent, looking for jets of water as the patient drinks is at times helpful. Of course, the position of tubes and bougies can be checked at any time with the roentgen ray.

When all efforts at permeation have failed, the patient must be condemned to a gastrostoma for life, run the risk of perforation in an attempt to permeate the stricture under the biplane fluoroscope, or undergo external surgical operation as advocated here.

Many strictures have been permeated successfully by skilled operators under the biplane fluoroscope, as has been repeatedly proven in the Philadelphia clinics.

However, since many of us do not have such a skilled team available and work in hospitals which do not have biplane fluoroscopes, any other safe method should be useful in certain cases, particularly when it removes the dread of perforation and mediastinitis. As Chevalier Jackson has said, the esophagus is the most intolerant of viscera.

Noting the exposure obtained in instituting external drainage in perforations of the esophagus due to instrumentation and foreign bodies and in operations on diverticula, it seemed practicable to apply the same operation to impermeable strictures. Since the introduction of the various sulfonamides, which can be used as dusting powder locally or can be given by mouth, an extra factor of safety has been provided. The advances in thoracic surgery in recent years have been so great that today any portion of the esophagus is accessible to external exposure, and when necessary, external exposure can be employed to facilitate the permeation of strictures.

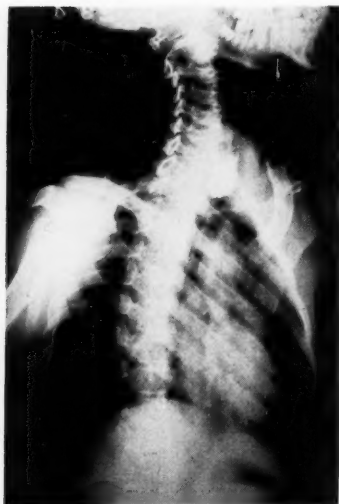


Fig. 2. Case 1.—Complete stenosis one month later. The esophagus is dilated and atonic above the stricture. Complete stenosis seems to occur more rapidly under gastrostomy feeding and rest of the esophagus.

We have employed external operation in three patients, two for complete cicatricial stenosis and one with marked spasm of the cricopharyngeus and suspected tumor, with success in two. The third patient had a very extensive stricture involving the major portion of the esophagus, from drinking lye in an attempt at suicide. Although we were unsuccessful by cervical exposure at one time and abdominal exposure at another time, we still feel that it is possible by more extensive thoracic exposure and are planning to carry this procedure out in the near future. Dr. E. C. Drash, of the Department of Thoracic Surgery, is responsible for our success in these patients.

CASE 1. (No. 161,808.) A 12-year-old boy accidentally swallowed lye five weeks before admission. He had been able to swallow liquids for the past two weeks before admission, had lost weight, and had pain and difficulty in swallowing.

X-ray showed a marked stricture 2 cm. long in the upper third of the esophagus, so he was referred to the department of surgery for gastrostomy (Fig. 1).

The first stage was done on the day after admission and the second stage five days later.

The wound was well healed in two weeks, and feedings were carried out through the gastrostomy tube. The patient was then transferred to our service, and an attempt to have him swallow a string was unsuccessful. We were also unable to pass a ureteral bougie either through the mouth or esophagoscope. Since the patient was now unable to swallow liquids, another X-ray was made which showed no barium passing the stricture. This fact was noted four weeks after admission or nine weeks after the ingestion of lye. During the next three weeks, repeated attempts to pass a string or bougie from above or below were unsuccessful, so it was decided to employ external exposure to permeate the stricture.

He was operated upon on Nov. 16, 1940, approximately seven weeks after admission, by Dr. E. C. Drash, who noted as follows:

"Under avertin and ether anesthesia an incision was made along the posterior border of the right sternocleidomastoid muscle. Dissection proceeded down to the esophagus, passing laterally to the carotid sheath. The esophagus was identified without difficulty. Repeated attempts were then made to pass bougies of various materials, tensions, and degrees of sharpness. These attempts were all unsuccessful; in fact, a sharp-pointed metal instrument passed through the wall of the esophagus out into the neck on three different occasions. All important structures were carefully packed off during this manipulation, which was done slowly and carefully. During these manipulations, a bougie was passed through the gastrostomy opening by an assistant. The tip of the bougie which ascended the esophagus could be felt in close proximity to the tip of the bougie which descended the esophagus. At times the two tips seemed to be only a few millimeters apart. It was, however, impossible to permeate the stricture from above. The bougie from below was manipulated by an assistant. This seemed unsatisfactory, so the surgeon grasped the esophagus with his left hand and manipulated the bougie from below through the gastrostomy with his right hand. In this way it was possible to guide the lower bougie much more accurately than had been possible previously by giving direction to the assistant. By this method the lower bougie presented such a clear and well-defined prominence (as seen from above) that it was possible to incise the mucosa overlying the tip of the lower bougie and to allow it to pass freely into the upper esophagus. This entire procedure was guided by the fingers of the left hand of the surgeon which encircled and manipulated the esophagus from the outside. This part of the procedure was carried out with surprising ease, considering the long drawn-out and futile attempts that had been made previously. At the conclusion of this procedure there was no evidence of leakage from the three tiny perforations in the wall of the esophagus. However, sulfanilamide powder was sprinkled freely around the circumference of the esophagus, and a soft rubber drain was brought out at the lower angle of the wound. The incision in the neck was then closed loosely, using interrupted plain No. 0 catgut for the buried sutures and interrupted fine silk for the skin. In spite of the prolonged operation, this boy went through it quite well."

The neck wound was healed in eleven days and a new string passed and retrograde dilatation started. The patient was discharged one month later, and the stricture had been dilated up to 30 F.

CASE 2. (No. 79,526.) A 73-year-old woman, who had been having increasing difficulty in swallowing for the past two years, was only able to swallow liquids, had lost twenty pounds, had frequent attacks of strangling. A sensation of fullness in her chest, a voice weakness, and frequent expectoration were also present.



Fig. 3. Case 1.—The radiopaque ureteral bougie is turned back by the complete stricture, when approached from below.

Complete physical examination was negative, except for the X-ray findings.

Fluoroscopic examination of the esophagus the day after examination showed marked difficulty in swallowing. The barium collected in a small pocket at the level of the upper border of the larynx, and since none entered the esophagus, the esophagus could not be examined.

The following day an esophagoscopy showed marked obstruction at the upper end. No lumen could be found, and the mucous membranes were normal. Since we suspected that we might have entered a diverticulum, the examination was discontinued, and further X-ray studies were ordered.

The next day a lateral X-ray of the neck showed a definite rounded mass 5 mm. in thickness, compressing the posterior aspect of the trachea from the upper level of the larynx downward for 2.5 cm. When barium was swallowed, it stopped as before, but a small trickle entered the esophagus. It was concluded that there was apparently a tumor mass in the esophagus, pressing on the trachea.

An attempt to swallow a string the following day was unsuccessful, so a second esophagoscopy was done for the purpose of obtaining a biopsy, if possible. No mucosal changes were noted, however, and we were again unable to enter the esophagus. Several bits of tissue were removed for microscopic examination. The

pathologic report showed benign scar tissue with normal overlying epithelium. Because of this mass of conflicting evidence, we advised external exposure. On Aug. 27, 1940, Dr. E. C. Drash operated upon her, noting the following:

"Under avertin and novocaine anesthesia, an incision was made along the posterior border of the right sternocleidomastoid muscle. The dissection was carried down to the esophagus which was carefully dissected free from the surrounding structures. At no point could any evidence of diverticulum be seen, nor were any other abnormalities evident from an examination of the esophagus on the exterior. At this point the esophagoscope was again inserted in the hypopharynx, and by making traction on the incision in the neck, the esophagoscope passed easily down into the lower portion of the esophagus. With the esophagoscope in place, a tube was inserted into the stomach. No reason for the obstruction could be determined, either by examining the esophagus from the outside or by the examination through the esophagoscope on the inside. The patient stood the operation well. The wound was closed loosely, after dusting with sulfanilamide powder, using plain No. 0 catgut for the deeper stitches and silk for the skin, leaving in place a small, soft rubber drain at the lower angle of the wound."

She was given sulfanilamide by mouth for five days, after which the stomach tube was removed and soft diet started. She swallowed quite well, so a regular diet was given three days later, which she took without difficulty.

The neck wound had healed, and she was discharged several days later, eating normally, and has had no further trouble of any great consequence.

We were apparently dealing with a marked spasm of cricopharyngeus with some psychogenic factors in addition, and whereas one might say the operation was not justified, I still believe it was the safest and surest way to relieve her symptoms and to rule out diverticulum and tumor definitely.

This was not a case of impermeable cicatricial stenosis, but is included in this report to illustrate the application of this procedure in similar situations.

CASE 3. (No. 83,192.) A 27-year-old woman was admitted in June, 1930, with a history of having swallowed a large amount of lye nine months previously. She was subsisting entirely on liquids in small amounts and had lost considerable weight.

X-ray examination on admission showed a marked stricture high up in the upper third of the esophagus and another stricture in the lower third, so immediate gastrostomy was done. Repeated attempts at permeation both from above and below were unsuccessful, and X-ray two months after admission showed complete occlusion.

She was sent to Dr. Gabriel Tucker, in Philadelphia, for permeation under the biplane fluoroscope, but he was unsuccessful after repeated attempts.

Two years later she was again examined, but no opening could be found. She returned to the hospital for external operation. The esophagus was examined by fluoroscopy again in February, 1941, and the stricture was found to be still complete. Likewise per oral and retrograde esophagoscopy was negative.



Fig. 4.



Fig. 5.

Fig. 4. Case 2.—The mouth and pharynx are filled with barium, but none has entered the esophagus.

Fig. 5. Case 2.—A lateral view of the neck shows an apparent esophageal tumor, compressing the trachea.

We felt that passing a bougie up from the stomach offered the best chance of permeation, but since we were unable to identify the lower end of the esophagus by retrograde esophagoscopy, it was decided to open the abdominal wall for the purpose of guiding the bougie under finger manipulation. Dr. Drash's notes are as follows:

"Under spinal anesthesia a high upper abdominal incision was made and the peritoneum opened. The lower end of the esophagus between the diaphragm and the stomach was found without difficulty; and after numerous attempts, a stiff bougie was finally apparently directed into the esophagus. After this was accomplished, the incision in the abdominal wall was closed in layers, using plain zero for the peritoneum, chrome zero for the superficial fascia, and silk for the skin.

"The patient was then taken to the fluoroscopy room and the bougie examined under the fluoroscope. Unfortunately, it was found that the bougie could not be made to pass farther up the esophagus than the level of the diaphragm. There seemed to be no doubt that the bougie was actually in the lower end of the esophagus while the operator's hand was inside the peritoneal cavity.



Fig. 6.



Fig. 7.

Fig. 6. Case 3.—Showing a marked stricture in the upper third, with barium entering the lower esophagus. Fluoroscopic examination showed a second stricture in the lower third, not shown in this film. This was the condition on admission in 1930.

Fig. 7. Case 3.—Complete stenosis two months later. As in Fig. 2, the esophagus is dilated and atonic above the stricture. Again, gastrostomy feeding and rest of the esophagus seemed to favor the development of complete stenosis.

"The patient went through this lengthy manipulation in good condition."

The abdominal wound soon healed, so we decided to try permeation from above the next time. She returned two months later for a second attempt.

On May 9, 1941, the upper esophagus was exposed by Dr. Drash. His notes are as follows:

"Under avertin and ether anesthesia, an incision was made along the posterior border of the right sternocleidomastoid muscle. The esophagus was approached by retracting the carotid sheath medially. It was carefully freed from a point above and below the thoracic entrance upward to its junction with the posterior pharynx.

"Various bougies were then passed down the esophagus and manipulated by the fingers of the surgeon in an attempt to guide the instrument down the lumen of the esophagus. After about one hour of manipulation with various types and sizes of instruments, the procedure was abandoned because it was quite impossible to penetrate the stricture. It is felt that had it been possible to pass a bougie upward from below, it might have been possible to permeate this stricture. At no time was there any evidence of perforation of the esophagus. However, a small amount of sulfanilamide powder was sprinkled around the circumference of the esophagus, and a soft rubber drain was brought out at the lower angle of the wound. The incision in the neck was closed rather loosely, using interrupted plain No. 0 catgut for the buried sutures and interrupted fine silk for the skin."

The patient plans to return for another attempt, through wide thoracic exposure. She is able to lead a normal life, and maintains her nutrition by chewing her food and then expectorating it into a funnel connected with the gastrostomy tube. Since this method is so unpleasant, she is willing to undergo any procedure which offers the possibility of normal swallowing.

CONCLUSIONS

External exposure of the esophagus is advocated as a safe surgical procedure for the permeation of complete esophageal strictures, in selected cases, when other methods have failed.

VII

NASOPHARYNGEAL FIBROMA, WITH THE REPORT OF A CASE WITH SECONDARY PNEUMOCEPHALUS*

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Practically every writer on nasopharyngeal fibroma refers to the rarity of this condition in his opening paragraph. While the unique characteristics of these tumors are intriguing and probably account for the relatively large number of contributions dealing with this subject, most authors necessarily have had to limit their personal observations to a small number of cases. A noticeable exception to this is the paper by Figi,¹ read before the Section on Otolaryngology of the American Medical Association in 1940, which was based upon the study of 63 cases seen at the Mayo Clinic between 1910 and 1940. This paper is so comprehensive that any attempt at a detailed presentation of the subject at this time would seem preposterous.

The purpose of this paper is to stress the need for careful diagnostic studies in any case of nasal obstruction from what may appear to be polypoid formation, especially the necessity of thorough examination of the nasopharynx, and to describe a complication which, as far as I know, has not been reported in the literature.

In order to set the stage, as it were, it would seem fitting to review briefly some of the salient characteristics of these tumors. Thomson² classifies nasopharyngeal fibromas as histologically benign but clinically malignant. They are found almost exclusively between the ages of 10 and 25 years, and predominantly in males. Thomson suggests that the appearance of these tumors depends upon developmentally irregularities at puberty. They may originate from any part of the fibrous tissue of the nasopharynx, most commonly from the periosteum of the basilar process of the occipital bone and the body of the sphenoid bone. They may invade the sinuses, the orbit, the sphenomaxillary fossa, or the brain cavity. Their attachment is usually sessile and broad, and the tumors are not freely movable. They may develop secondary attachments to the nasal septum or the turbinates, somewhat resembling the tentacles of the octopus. Spontane-

*Read at the meeting of the Eastern Section of the American Laryngological, Rhinological and Otolological Society, Portland, Me., Jan. 15, 1942.



Fig. 1.—Lateral roentgenogram showing large pneumatocele in anterior fossa.

ous involution and disappearance may take place at about the age of 25 years if the patient has survived.

While these tumors are considered true fibromas their marked vascularity merits a more specific designation. Friedberg³ suggests that they be more properly termed "angiofibroma" or "vascular fibroma," and pathologists usually refer to them as juvenile basal fibromas. The blood vessels are thin walled, lack elasticity, and may be cavernous. This explains the profuse and persistent bleeding which occurs when these tumors are cut or traumatized.

Delavan¹ says that the earlier treatment of this condition constitutes one of the tragedies of surgical history. A high mortality rate, usually from hemorrhage, accompanied the then-accepted procedure of surgical removal. That this was not even higher might be attributed to mistaken pathological diagnoses, or to the inclusion of other than true nasopharyngeal fibromas in the reported cases. During the past 25 years the trend has been away from surgical removal and the treatment accepted now is radiation, preferably with radon implants, and electrocoagulation.

The insidious nature of these growths is characteristic and accounts for the fact that they are rarely, if ever, recognized in their earliest stages. The symptoms which generally bring them to the attention of the physician are nasal obstruction and discharge and epistaxis.

While histopathologic study would seem essential in the diagnosis of any tumor there has been a growing tendency to eliminate biopsy in these cases, because of the possibility of serious bleeding. This seems logical provided the history and clinical appearance of the lesion are sufficient to warrant the diagnosis. This presupposes a meticulous examination of the nasopharynx, something that is too frequently neglected. Direct inspection, together with gentle palpation, may reveal the typical firm, smooth, or lobulated reddish tumor, quite immobile and with a sessile base. In young people, when it is difficult to encompass this satisfactorily, there should be no hesitancy in employing a general anesthetic to get a more complete examination. The tumor may be practically imbedded in adenoid tissue, as in the case I am reporting, making a general anesthetic necessary to obtain a proper conception of the condition and at the same time to avoid undue trauma. The tumor which has extended forward into the nasal cavity is more apt to cause difficulty in the diagnosis, especially if there has not been a careful inspection of the nasopharynx. This nasal extension is apt to be lighter in color and more easily confused with the ordinary nasal polyp. While biopsy may not be necessary in all cases, a specimen can be taken from the nasal extension of the tumor, using the coagulating current, followed by packing, if necessary, with much less risk than from the nasopharynx. Obviously complete roentgen studies are indicated. Oftentimes these will give surprising information as to the extent of the tumor.

Except for hemorrhage the occurrence of severe symptoms of rapid onset has been noticeably absent from reports in the literature. As stated before, a slow insidious progression is characteristic. The sudden onset of severe prostration and headache, dramatic in intensity, prompts the reporting of the following case.

CASE REPORT

R. S., a boy, 13 years of age, was seen because of right-sided nasal obstruction of three years' duration. There was a family history of allergy. Tonsil and adenoid operations had been performed several years before. Ten months previously an attempt had been made in another city to remove a polyp but had not been completed, apparently because of bleeding. As the antrum had been punctured at this time, I suppose the physician had considered the condition due to a polypoid sinusitis. Nothing further had been done in the interim.

Examination revealed the right nasal cavity completely occluded by a polypoid mass, attached at points to the mesial surface of the middle turbinate and to the septum. There was considerable mucopurulent discharge, cytologic examination showing a marked eosinophilia. Nasopharyngeal examination was rather unsatisfactory due to the marked gagging and lack of cooperation on the part of the patient, but revealed a dark reddish tumor mass in the right side of the vault surrounded



Fig. 2.—Anteroposterior view showing pneumatocele.

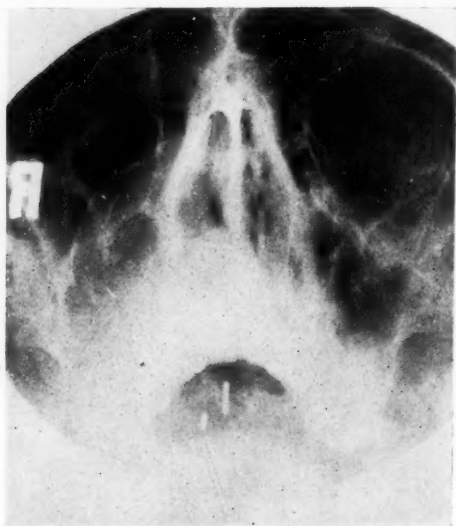


Fig. 3.—Anteroposterior view nine days later showing pneumatocele absorbed.
Radon implants seen in place.

with adenoid tissue. The boy was admitted to the hospital for examination under a general anesthetic. Retraction of the soft palate showed a dark reddish firm tumor attached to the right upper surface of the vault by a wide sessile base. Surrounding this was a mass of soft adenoid tissue, the result of an incomplete adenoidectomy. The tumor could be seen extending forward through the posterior choana. At this point it was narrowed laterally, presenting a lobulated appearance. This anterior extension was grayer in color, the dark red hue of the main tumor fading out. While there seemed to be no doubt as to the diagnosis I decided to perform a biopsy, taking a small specimen from the nasal extension. While there was free bleeding it was easily controlled by packing.

Microscopically the specimen showed a fibrous stroma, freely infiltrated with round cells and in several areas a mucinous matrix with spindle cells. Capillaries were dilated and grouped into nests. Frequent eosinophiles were noted in one area. The picture was consistent with juvenile basal fibroma.

Meanwhile roentgen examination showed an opacity of the right antrum, ethmoids, and sphenoids, with destruction of the cell walls of the ethmoid and an extension into the orbit posteriorly. No bony detail of the sphenoid could be made out and the pituitary fossa was not demarcated. The lateral view demonstrated the tumor mass in the nasopharynx.

Ophthalmologic consultation revealed rather marked proptosis, but there was no oculomotor disturbance and the fundus was normal.

Roentgen therapy was instituted, while awaiting the procurement of radon seeds. The boy had been feeling as well as usual and it had been difficult to confine his activities. Suddenly he had an attack of severe pain in the head and became markedly prostrated, with all the appearance of shock. Headache was increased by moving or jarring. Neurological examination was negative except for some stiffness of the neck. Temperature was normal at all times. I was entirely unable to account for this sudden change until roentgen examination revealed a large, sharply defined pneumatocele in the floor of the anterior fossa, measuring 7 cm. in breadth, 3.5 cm. in length, and 1.7 cm. in depth. What appeared to be a stalk could be seen running upward and forward from the tumor to the pneumatocele. There was a generalized scalloping of the sutures, indicating increased intracranial pressure.

The boy was kept absolutely quiet. The headache gradually disappeared and nine days later roentgen examination showed that the pneumatocele practically disappeared.

In the meantime radon seeds, delivering a dosage of 2,000 mc. hours, had been implanted in the tumor.

One month later examination showed the tumor decreasing in size. Since this time the mass has still further diminished, both intranasally and in the nasopharynx, although still filling the region of the olfactory groove rather completely. The stalk seen in the lateral roentgenogram appears about one-third of its original width. The adenoid tissue has completely disappeared as far as one can see, indicating the radiosensitivity of lymphoid tissue in comparison to the fibroma. Naturally the patient is still under observation and treatment.* This case is reported before completion because of the unusual complication of a pneumocephalus.

*Since this paper was written additional radon needles delivering a dosage of 2,000 mc. hours have been implanted in the tumor.



Fig. 4.—Lateral view taken at the same time as Fig. 3. Note large stalk of fibroma.



Fig. 5.—Lateral view taken two months later, shewing shrinking of stalk.

SUMMARY

A case of nasopharyngeal fibroma had been mistakenly diagnosed elsewhere as a polypoid sinusitis; largely because of incomplete examination of the nasopharynx. When seen there was marked intranasal extension with involvement of the ethmoids, orbit, and sphenoid. Erosion through the roof of the ethmoid, possibly in the cribriform plate, allowed the sudden development of a pneumatocele. This resulted in sudden severe prostration and headache. The pneumatocele disappeared in nine days under bed rest. Radiation treatment with radon implants has caused marked decrease in the size of the tumor. Earlier recognition of the nature of the condition would have indicated the proper therapy and would probably have prevented the upward extension with all its implications.

CONCLUSIONS

1. Accurate visual examination of the nasopharynx is essential. Failure in this respect is the cause of many diagnostic errors.
2. Direct inspection by retraction of the soft palate is the most accurate method of examination of this region. The use of a general anesthetic for this purpose may be indicated in such cases as suspected nasopharyngeal fibromas.
3. While biopsy may be attended with the risk of hemorrhage in nasopharyngeal fibromas and may be dispensed with in most cases, the hazard of bleeding may be better managed if taken from the nasal extension of the tumor.
4. The sudden onset of severe prostration and headache in a condition with the potentiality of intracranial extension should suggest the possible diagnosis of pneumocephalus.

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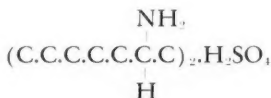
VIII

2-AMINO-HEPTANE SULFATE AS A NASAL VASOCONSTRICTOR*

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The pressor action of the compound 2-amino-heptane sulfate recently brought to light, suggests its use as a nasal vasoconstrictor. It has a special interest in that unlike the other constrictors now in use it belongs to the aliphatic group of compounds; it has the simple structure



Following suggestions of Shonle and Rohrmann that certain aliphatic amines having the amino group on the second carbon atom might show interesting pressor action, Chen and Swanson have recently made a thorough investigation of the pharmacological properties of this compound.¹ Curiously this pressor action is pronounced only when the amino group is attached to the second carbon atom in the chain. The compound bearing this group in the first position is relatively inert.

The base 2-amino-heptane is only slightly soluble; for this reason the experiments upon the nasal mucosa herein described were carried out with the sulfate. Aside from any advantage which may be derived from its chemical simplicity it has also potency, freedom from local and systemic toxicity and sustained action without any apparent deleterious after-effects.

In a letter to the author regarding the antecedents of this compound Chen² writes:

"Although 2-amino-heptane was known as early as 1863 (Ca-
hours, A., and Pelouse, J.: *Jahrsber. d. Chemie*, 528, 1863; Schorlem-
mer, C.: *Liebigs Ann. d. Chem.* 127, 318, 1863), its characterization

*From the Department of Otolaryngology, Washington University School of Medicine.

was achieved by Clarke in this country (Clarke, T.: J. Am. Chem. Soc. 21, 1027, 1899)."

"2-amino-heptane sulfate raises the blood pressure and decreases the nasal volume in animals. It also dilates the pupils of rabbits by local application. Its activity and toxicity as compared with ephedrine and amphetamine are as follows:

Activity (In Cats)

<i>Drug</i>	<i>Activity in %</i>
Ephedrine sulfate	100
Amphetamine sulfate	66
2-amino-heptane sulfate	52

Toxicity (Intravenously in Mice)

<i>Drug</i>	<i>Median Lethal Dose M (L D₅₀ \pm S.E.)</i>
Ephedrine sulfate	109.8 \pm 5.86
2-amino-heptane sulfate	36.93 \pm 1.335
Amphetamine sulfate	5.603 \pm 0.427

"Five individuals volunteered to take a dose of 25 milligrams each by mouth. Their blood pressure was determined at hourly intervals. No elevation of blood pressure was noted. The product in this dosage, therefore, does not appear to produce systemic effects."

Isotonic solution of 2-amino-heptane sulfate may be prepared as follows:

2-amino-heptane sulfate	gm. 2.0
Sodium chlorid	gm. 0.406
Distilled water to make	gm. 100.0

The pH of a 2 per cent solution of 2-amino-heptane sulfate has been determined to be 5.7.

The present experiments come under two headings, 1) observations of the effects of the drug upon the cilia of laboratory animals and upon fragments of membrane from the human nose, and 2) clinical observations of the effects upon the nasal mucosa of patients with normal noses and with varying degrees of inflammatory and allergic swellings.

Specimens of mucosa were taken from the rabbit's trachea and nasal chambers including the sinuses, immediately after the death of

the animal by bleeding, and were promptly immersed in 0.9 per cent sodium chlorid solution. Certain portions were segregated as controls and the others were subjected to various dilutions of the drug.

Details of individual experiments are omitted from this report partly for the sake of brevity, but chiefly because they showed so little variation.

Solutions of 2 per cent 2-amino-heptane sulfate with sodium chlorid had no apparent effect upon the cilia either as to rate or vigor of beat for periods from 23 to 25 minutes, after which the motion was slowed. Complete cessation of motion occurred in between 46 and 135 minutes. The solution was frequently replenished but never removed entirely from the specimen.

Solutions of 4 per cent 2-amino-heptane sulfate with sodium chlorid had no apparent effect upon the cilia either as to rate or vigor of beat for periods from 18 to 22 minutes, after which the motion was slowed. Complete cessation of motion occurred in between 45 and 65 minutes. The solution was frequently replenished but never removed entirely from the specimen.

A 4 per cent solution in distilled water stopped motion in 54 minutes, a 2 per cent in distilled water in 79 minutes, and a 1 per cent in distilled water in 20 minutes plus.

Since all of these periods were far in excess of clinical requirements, some of the experiments were terminated before ciliary action stopped. The room temperatures were 22°C to 25.5°C.

For the clinical tests a stock solution was prepared containing 2-amino-heptane sulfate gm. 2, sodium chlorid gm. 0.5, aq. dest. q.s. ad. gm. 100. This solution contained gm. 0.094 more sodium chlorid than the amount stipulated for a perfectly isotonic solution but was adopted for ready preparation in the office. Further dilutions were made when required, with 0.9 per cent sodium chlorid solution.

In the first series (31 observations) 2 per cent 2-amino-heptane sulfate solution was applied to the right nasal fossa by means of an atomizer, 2 per cent ephedrine sulfate to the left.

In the second series (31 observations) 1 per cent 2-amino-heptane sulfate solution was applied to the right nasal fossa by means of an atomizer, 2 per cent ephedrine sulfate to the left.

In the third series (57 observations) 0.5 per cent 2-amino-heptane sulfate solution was applied to the right nasal fossa by means of an atomizer, 2 per cent ephedrine sulfate to the left.

With the 2 per cent solution, shrinking of the nasal mucosa exceeded that produced with 2 per cent ephedrine 21 times in 31. In five cases the effects were approximately equal and in five cases there was little response to either drug, owing probably to hyperplasia which was present or to some circulatory defect. One of these patients was a chronic alcoholic, another an amphetamine addict.

In all cases in which any effect was produced (26 cases) the ischemia was greater than that produced by ephedrine.

Of the 31 patients treated with 1 per cent 2-amino-heptane sulfate it may be said that this drug was uniformly more effective than the 2 per cent ephedrine. In one case in which ephedrine produced only minimal change, a subsequent application of 2-amino-heptane sulfate was effective.

Using the 0.5 per cent 2-amino-heptane sulfate solution, shrinking was approximately the same as that with 2 per cent ephedrine on the opposite side. The ischemia was not conspicuous in this series.

COMMENT

From the clinical observations it appears that:

1. None of the 119 applications elicited any complaint of any nature from the patient. There was a notable absence of local tingling and of subsequent systemic reactions such as tremor, excitement, or insomnia.

2. Compared with a 2 per cent isotonic aqueous solution of ephedrine sulfate, 2 per cent 2-amino-heptane sulfate brought about much greater constriction and a more pronounced ischemia (the appearance approximated that following the application of a 1:1000 epinephrin); 1 per cent solution also showed greater constrictive effect than the 2 per cent ephedrine in every case; the 0.5 per cent solution of 2-amino-heptane sulfate approximated in its effect the 2 per cent ephedrine solution. In only three of the 57 cases was the ephedrine definitely more active.

3. In none of the 119 cases did the patient complain of a subsequent vasodilatation blocking the nose; in fact several spontaneously mentioned the absence of it.

4. In general the latent period preceding the constriction was somewhat longer than that of the ephedrine.

5. In three cases there was an excessive flow of mucus immediately following the application, which was evident also following ephedrine.

6. In one case there were traces of blood streaking the nasal mucus several hours after the application of 0.5 per cent solution. This appears to have been due to excessive ventilation and drying in a nose already inclined to dryness.

From the laboratory observations it appears safe to make these deductions for clinical purposes:

1. 2-amino-heptane sulfate in concentrations up to 4 per cent and in solutions approximating isotonicity has no deleterious effect upon cilia of the upper respiratory tract when applied for periods customary to clinical practice.

2. The condition of the mucosa in the various specimens suggests that impediment of ciliary action when noted is the result rather of departure from isotonicity than of the concentration of the salt *per se*.

Following the completion of the systematic observations, the author has used 2-amino-heptane sulfate in his private practice to the exclusion of other vasoconstrictors for ten weeks with satisfactory results. The following concentrations are convenient:

In atomizers, 0.5 per cent and 1 per cent respectively for routine shrinking, the choice depending upon the nasal response; in bottles, 2 per cent solution to be applied on cotton pledgets in cases requiring greater constriction for examination or for hemostasis.

Introduced into the sinuses by the displacement method, 0.2 per cent solution is effective and well tolerated.

1010 BEAUMONT BLDG.

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IX

A NEW PLASTIC FLAP FOR USE IN END-AURAL RADICAL MASTOIDECTOMY*

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CHICAGO

The purpose of the radical mastoid operation is to remove the area of chronic disease in the middle ear spaces and mastoid and to leave this area fully and permanently accessible through the external auditory meatus. The ideal radical mastoidectomy will accomplish the maximum of removal of infected tissue and will provide the maximum of permanent accessibility to the diseased area, with the maximum hearing, with the minimum of operative trauma and risk, the minimum of postoperative disability, and the least possible external deformity.

The end-aural approach for the radical mastoidectomy, utilizing the extracartilaginous incision of Lempert, compares with the post-aural approach in my experience as follows:

1. Since the infected tissue in chronic suppurating ears requiring the radical mastoid operation in the majority of cases lies largely around the middle ear, attic, aditus, and antrum, the end-aural approach offers as good or better accessibility for the complete and safe removal of this tissue.

2. The end-aural approach causes less trauma to soft tissue and diminishes the danger of perichondritis since the cartilage is not exposed or cut into as in the post-aural operation.

3. The risk of injury to the labyrinth and facial nerve is possibly less with the end-aural approach which is more direct and closer to these structures.

4. The postoperative disability is less with the end-aural approach because of lessened trauma to soft tissue. The external deformity is also less.

5. Most important of all, the completed cavity is more accessible after the end-aural incision, since the cavity has been created via

*Presented before the Chicago Laryngological and Otological Society, Monday, Oct. 6, 1941.

the same approach through which it must henceforth be viewed and kept clean. The overhanging edges that frequently occur after the post-aural operation are eliminated by the end-aural.

The end-aural incision described by Lempert for the radical mastoid operation extended in a V to the upper posterior margin of the drum membrane and did not involve a plastic skin flap. For several years I have employed instead the usual Lempert incision for the simple mastoidectomy, preserving the skin of the superior and posterior bony metal walls as a plastic flap to cover the facial ridge. This new plastic flap is easily made, requiring only a little care not to tear this skin in doing the bone work. It takes only a moment to make and has the great advantage of covering the entire facial ridge and at once eliminating the possibility of scar tissue adhesions between the facial ridge and the tegmen walling off the antrum. By hastening epidermization of the cavity, convalescence is shortened and the need of a skin graft is eliminated.

Before describing the technic of the end-aural radical mastoidectomy with this new plastic flap, at the risk of repetition, the indications for the classical operation, the Bondy modification, and the Heath modification will be briefly reviewed.

The commonest indication for the classical radical mastoid operation in my experience is cholesteatoma secondary to an acute necrotic otitis from scarlet fever or measles in early childhood. The drum membrane and mucosa lining the middle ear, attic, aditus, and antrum were destroyed by the acute necrotic otitis, and healing has occurred by the ingrowth of stratified squamous epithelium from the external auditory meatus to line these spaces. Masses of desquamating outer layers of the epidermis collect in attic, aditus, and antrum as cholesteatoma, called secondary cholesteatoma because it is secondary to an acute necrotic otitis. While attic irrigations may suffice to keep this debris cleaned out, in some cases the cavity is too large and inaccessible to be rendered dry by local treatment. The radical mastoid operation is then indicated to arrest the progressive erosion of bone that occurs around a moist infected cholesteatoma cavity.

Chronic osteitis of the temporal bone also requires the radical mastoid operation. Two varieties may be distinguished. The first frequently follows an acute necrotic otitis with scarlet fever or measles; the discharge is persistently foul in spite of treatment, but in one of my cases there was no discharge. The pathology consists of a granular hemorrhagic softening of the bone around the antrum

and frequently around the semicircular canals. The drum membrane perforation may be small or large, but the middle ear is lined by red mucosa. Because the osteitis may involve the bone around the semicircular canals, or the peritubal or hypotympanic regions, the classical operation should be done.

The other type of chronic osteitis resembles an acute suppurative otitis except that the mucopurulent discharge continues for months or years, with frequent exacerbations, and without coalescence of the mastoid cells. There is usually a granular softening of bone around the antrum along with sclerosis of the mastoid cells and a glairy mucoid material in these cells. A complete simple mastoidectomy does not seem sufficient in all of these cases, since the operative cavity tends to become reinfected with a persistent aural discharge. I believe that the Heath modified radical mastoidectomy is more suitable for these cases. The advantage of the Heath operation over the classical operation is that the middle ear, drum membrane and ossicles are left in place, while permanent drainage from the antrum is secured.

The classical radical operation is also indicated in certain cases of petrositis where the disease cannot be reached through the simple mastoidectomy.

The Bondy modified radical mastoidectomy is the operation of choice in cases of cholesteatoma with an intact pars tensa and a perforation in Shrapnell's membrane. This type of cholesteatoma probably begins as an invagination of Shrapnell's membrane without a preceding acute otitis. Wittmaack calls it the "true" or "genuine" cholesteatoma, but I prefer the term "primary acquired" cholesteatoma. As I pointed out in 1936, the Bondy operation preserves or improves the hearing in these cases by preserving the drum membrane and tympanic cavity, and this is particularly important where the ear requiring operation is the better hearing ear.

The technic of the end-aural radical mastoid operation and its modifications, with the use of the new plastic skin flap, is as follows:

I prefer a basal anesthesia of morphine gr. 1/4, scopolamine gr. 1/100, and nembital gr. 6 in divided doses, supplemented by sufficient nitrous oxide and oxygen by inhalation to keep the patient asleep. Novocaine 1 per cent and adrenalin 1:5000 is infiltrated into the site of the incision for hemostasis. A headlight should be used for illumination.

An ordinary nasal speculum is used to spread the meatus open. The special Lempert spear-shaped knife should be used. The first

incision begins at the 12:00 o'clock position at the junction of the hairy and nonhairy portion of the canal and is carried down the posterior canal wall, slanting outward to emerge at the 7:00 o'clock position for the right ear and the 5:00 o'clock for the left. This incision stops at the edge of the auricular cartilage. The second incision begins at the same point as the first, 12:00 o'clock, and is carried directly upward between the tragus and the auricle to a point midway between the meatus and the upper edge of the auricle. The third incision connects the lower extremity of the first with the upper extremity of the second incision following the anterior border of the auricular cartilage. The three incisions, first outlined, are then deepened to the bone. A flat periosteal elevator is inserted into the first two incisions and the periosteum is elevated over the entire mastoid process. The loosened triangular piece of skin, subcutaneous tissue and periosteum, is grasped with a hemostat, freed with scissors from its few remaining shreds of attachment, and is discarded. The special self-retaining retractor is then inserted. From this point on the operation is completed the same as through the post-aural incision with the exception of the plastic.

Briefly, the skin of the superior and posterior bony meatal walls is carefully separated from the bone and pushed down and forward. The cortex is removed with a gouge or a round cutting burr until the antrum is entered. The extent of the antrum aditus and attic is determined with a blunt explorer and the overhanging edges are completely removed with a Kerrison rongeur and curettes. The bony superior and posterior meatal walls are thinned down with curettes, and the thinned wall is removed with fine rongeurs until the notch of Rivinus lies opened. If the Heath modification is being done, the last bridge of bone across the notch of Rivinus is left in situ, and the incus and head of the malleus in the attic are not disturbed. If the Bondy modification is being done, the bridge is taken down and the notch of Rivinus, including the attic perforation, is opened widely, but without disturbing the ossicles and the drum membrane. If the classical operation is being done, the remnants of the ossicles and drum membrane are removed and the middle ear, attic, aditus, antrum, and the external auditory meatus are converted into a common cavity. The walls of the cavity are smoothed; any areas of granular softening or of cholesteatoma are followed to their limits, and the facial ridge is lowered until all parts of the cavity are easily viewed.

The plastic skin flap is now made by cutting the skin of the superior meatal wall anteriorly so that it can be folded back over the

facial ridge. A small gauze pack holds the skin flap in position; the cavity is filled with sulfathiazole powder and sterile vaseline is applied to the incision. If there is bleeding when the retraction is removed, the bleeding points are coagulated and a loose iodoform pack may be left in the incision. No sutures are required.

The after-care is extremely important to a good result. The incision is spread wide open on the fifth day and the packing and any blood clots are removed under sterile precautions. Sulfathiazole powder is blown into the cavity. The incision must be spread wide open every few days for another two weeks, at which time it will have epidermized and healed as an enlarged but not unsightly meatus. All postoperative dressings should be done under sterile precautions. Complete epidermization and a dry ear require from five to twelve weeks on the average.

The patient is allowed out of bed the second or third postoperative day, returns home on the fifth or sixth day, and thereafter wears only a piece of sterile cotton in the ear which he changes himself three times a day or as needed. The *Bacillus pyocyaneus* is frequently found in infected cholesteatomas and tends to cause a foul greenish or brownish discharge after operation. Tincture of merthiolate 1:1,000 as ear drops, cleanliness, light and air are usually effective.

During the past year the end-aural approach with the new plastic flap was used in five classical radical mastoidectomies, two Bondy modified radical mastoidectomies, and one Heath modified radical mastoidectomy.

SUMMARY

The end-aural approach for the radical and modified radical mastoidectomy appears to me to have many advantages over the post-aural approach, the chief of these being the improved end result, in that the completed cavity is more perfectly accessible for future care.

A new plastic skin flap is described which is simple and practical and quickly and easily made. It has the advantage of hastening healing and preventing pocketing.

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X

NEUROFIBROMA OF THE LARYNX

EMILY L. VAN LOON, M.D.

AND

SIDNEY DIAMOND, M.D.

PHILADELPHIA

Neurofibroma, although common in other parts of the body, is rarely encountered in the larynx. We have been able to find but six cases on record. New and Erich,¹ reviewing 722 benign growths of the larynx seen at the Mayo Clinic over a 30-year period, report only one neurofibroma. In our clinic at Temple University Hospital, the case to be described is the first such tumor observed in the last 12 years, during which time several thousand laryngeal neoplasms have come under our scrutiny.

All but one² of the patients with neurofibroma of the larynx have been women. The youngest patient in the series is a woman of 23 observed by Jackson,³ the oldest, a woman of 50 seen by Vail.⁴ With the exception of Colledge's⁵ patient, who had a generalized neurofibromatosis in addition to her local lesion, the laryngeal neurofibroma has not been associated with growths of a similar nature elsewhere in the body. In the larynx itself the tumor has been found in various locations, but it has been a solitary one in every instance. In the case cited by Jackson³ and in the one mentioned by New and Erich,¹ the neurofibroma arose in a vocal cord. The right aryepiglottic fold was the site of the growth in the patients observed by Vail⁴ and by Colledge,⁵ the left aryepiglottic fold, in the patient described by Holmgren and Bergstrand.² A ventricular band was the point of origin in Tucker's⁶ patient. The tumors have varied greatly in size, the maximal diameter of the largest⁵ being nearly 4 cm., that of the smallest,¹ only 8 mm. The surface continuity of the laryngeal epithelium has been maintained in every case.

Despite the proximity of the neurofibroma to nerve tissue, its presence has not been accompanied by pain in any of the patients. In the patients described by Vail⁴ and by Colledge,⁵ the lesion attained so large a size that it produced a significant occlusion of the glottic airway, with consequent stridor and dyspnea. In the case of Colledge's⁵ patient, there was in addition some encroachment upon the

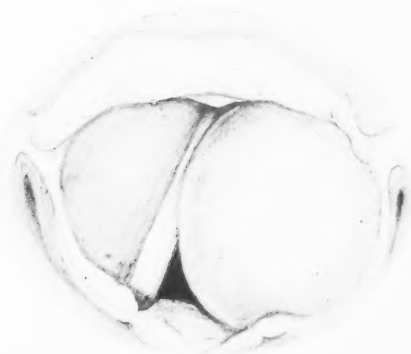


Fig. 1.—Indirect view of larynx in January, 1941, prior to operation. Left ventricle is completely obliterated by smooth tumor, which causes lateral wall of larynx to bulge into left pyriform fossa.

hypopharyngeal space, resulting in moderate difficulty in swallowing. Otherwise, hoarseness and loss of phonatory volume have been the only symptoms noted. The growth of the tumor is peculiarly slow, with the degree of vocal impairment gradually increasing over a period of months or years. In Tucker's⁴ patient, the duration of symptoms was 14 years.

CASE REPORT

The patient, a robust 17-year-old white girl, first came under our observation in July, 1940, with a history of progressively increasing hoarseness for approximately one year. Prior to the onset of her hoarseness, the patient had always been in excellent health. The findings in the general physical examination and the routine laboratory tests at the time of her initial visit were essentially normal, and they remained normal throughout her subsequent course.

On inspection of the larynx with a mirror and a laryngoscope, a smooth swelling involving the whole of the left ventricular band was noted. Aside from a slight thickening of the left vocal cord, the other laryngeal structures presented a normal appearance. The cords moved symmetrically with respiration and came into apposition in the midline on phonation. The ventricular mass felt rather soft, almost cystic in consistency, when palpated with laryngeal forceps. Considerable difficulty was experienced in getting specimens of tissue for biopsy, the bulge because of its large size and even surface exhibiting a distinct tendency to retreat from the grasp of the forceps blades. Several small pieces were removed, but they were found to contain nothing but normal epithelium and a few muscle fibers.

The patient was examined periodically during the next six months. A gradual increase in the size of her laryngeal tumor, paralleled by an aggravation of her hoarseness and a reduction in the loudness of her voice, was noted. By January,



Fig. 2.—Planigraphic film of larynx in January, 1941, prior to operation. Tumor is smoothly rounded and extends slightly beyond the midline.



Fig. 3.—Lateral planigraphic film of larynx in January, 1941, prior to operation. Tumor occupies entire anteroposterior diameter of larynx.

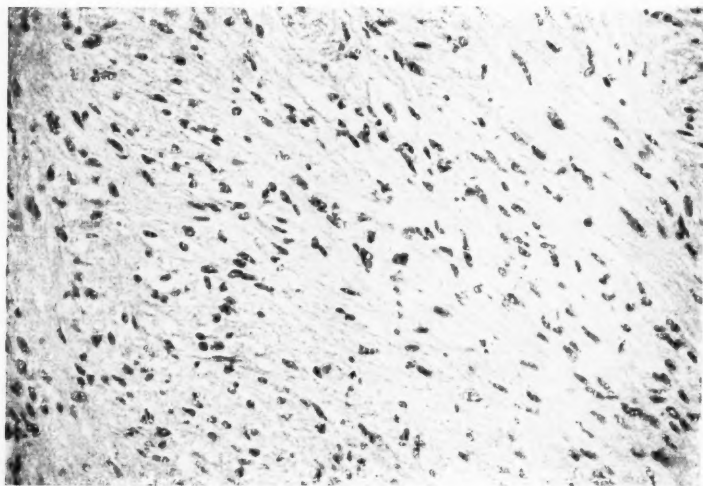


Fig. 4.—Section of tissue from tumor removed at laryngofissure. Histologic structure is typical of neurofibroma.

1941, the left ventricle had become completely obliterated and slight outward bulging of the left lateral wall into the pyriform fossa was evident. Laryngeal motility remained unimpaired, however. Additional tissue for histological study was obtained on two occasions, but the microscopic picture was not conclusive. In view of the progressive nature of the lesion and its concomitant symptomatology, removal of the growth by external operation was deemed advisable.

A laryngofissure was performed Jan. 24, 1941. Under local anesthesia, a midline longitudinal incision was made in the neck, exposing the thyroid and cricoid cartilages. After hemostasis had been effected, the cricothyroid membrane was incised vertically and the interior of the larynx anesthetized by the topical application of 10 per cent cocaine through the opening. The thyroid cartilage was then divided in the midline and the inner aspect of the larynx was brought into view. A smoothly rounded mass 3 cm. in diameter was seen to occupy the entire left side of the larynx, effacing the ventricle. The mucous membrane covering the mass was incised at its anterior end. The underlying growth was found to be surrounded by a thin capsule, which was easily freed from the adjacent tissue by blunt dissection, and the encapsulated tumor was enucleated in toto. In anticipation of possible postoperative edema, an opening was made in the lower part of the cervical trachea and a tracheotomy tube inserted. The superficial incision was closed without drainage, with buried steel wire sutures for the fascia and the muscles and Michel's clamps for the skin.

On gross section, the tumor mass was pink in color and rather soft. Microscopically, it was found to be extremely cellular. The cells were fusiform, were strikingly uniform in size, and showed a moderate tendency toward a palisade arrangement. The nuclei were rather finely granular, although the chromatin stained deeply. The cytoplasm stained a pale pink and was somewhat vacuolated, and the cell membranes were poorly defined. Only a scanty stroma was present. The histological diagnosis by Dr. L. W. Smith and Dr. M. E. Sano was neurofibroma.

The patient's postoperative course was uneventful. Her temperature rose to 100.4° F. the day following the operation, remained slightly elevated for three days, then returned to normal and continued to be normal thereafter. She suffered from difficulty in swallowing for a few days, but this discomfort soon disappeared. The anticipated swelling of the left side of the larynx resulting from the operation gradually regressed, and on the eighteenth postoperative day the tracheotomy tube was removed.

Repeated mirror examinations of the patient's larynx since her discharge from the hospital have failed to disclose any evidence of recurrence of the tumor. A single band of tissue which has a smooth medial border and moves sluggishly on phonation is present on the left side. Nothing suggesting a ventricle can be seen. For a short time after the operation the patient was able to do little more than whisper; but since then her voice has developed considerable power, although its tone is still definitely husky.

COMMENT

With one exception,² extirpation of the laryngeal neurofibroma has been undertaken in all of the recorded cases. The tumor has been removed perorally by suspension laryngoscopy in two patients^{1, 4} and by external operation in the remainder. In none of the patients

has any difficulty been encountered in effecting the separation of the neoplasm from the surrounding tissue. Ewing,⁷ in describing the gross pathology of neurofibroma, calls attention to the characteristically ready enucleability of the tumor; he points out that even in instances in which it reaches large dimensions it almost invariably remains well-encapsulated, facilitating its operative removal.

Comparatively few neurofibromata in other parts of the body recur after adequate resection. Of the laryngeal cases, a reappearance of the tumor has not been noted in any. The prognosis in our patient, therefore, appears to be quite favorable. Her voice, however, will in all likelihood remain somewhat husky.

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XI

ORBITAL CELLULITIS*

L. J. WALLNER, M.D.

CHICAGO

Orbital cellulitis may be defined as an acute inflammation of the soft tissues of the orbit, characterized by redness and edema of the lids, proptosis, and limitation of motion of the globe, chemosis of the conjunctiva, and a septic temperature. Cases of simple edema of the lids from acute sinusitis or from local infections are not included.

The special anatomy of this region and the relation of the sinuses to the orbit is well known. Of especial interest are the veins. The superior and inferior ophthalmic veins drain the area supplied by the ophthalmic artery. The superior ophthalmic receives the anterior and posterior ethmoidal veins and has a large communication with the facial system through the angular. The inferior ophthalmic communicates with the pterygoid plexus. The two ophthalmic veins do not follow the artery out of the orbit but leave through the superior orbital fissure to enter the anterior wall of the cavernous sinus. There are no lymphatic vessels or nodes in the orbit.

The commonest cause of orbital cellulitis is acute sinusitis, accounting for 70 to 80 per cent of all cases. Infection of the frontal sinus is said to be the commonest cause in adults, of the ethmoid, in children. Especially in infants, the sinus condition may be mild or unnoticed until attention is called by the orbital involvement. The sinusitis associated with scarlet fever often is a cause. The acute fulminating sinusitis following swimming seems especially liable to cause orbital involvement. Cases are much more frequent in infants and young children than in adults. Trauma from penetrating wounds or foreign bodies in the orbit should be mentioned as a cause. Cases have been seen from accidental puncture of the orbit while irrigating the antrum.

The pathology has been variously described as: (1) a true cellulitis of the soft tissue of the orbit, which may progress to phlegmon

*Presented before the Chicago Laryngological and Otological Society, Jan. 6, 1941.

or abscess; (2) a subperiosteal abscess outside the orbit proper and between the periosteum and bone; (3) a thrombophlebitis of the orbital veins.

In cavernous sinus thrombosis it is the blocking of the orbital veins that causes redness and edema of the lids, proptosis and chemosis of the conjunctiva. The same symptoms are present in orbital cellulitis. Could they not be produced in the same manner, by venous stasis, whether by subperiosteal abscess, true cellulitis or a thrombophlebitis?

Some simple experiments were done on dogs in an attempt to cause pressure on the orbital veins. After incision and elevation of the periosteum sterile gauze was packed between the periosteum and the bone, simulating an abscess. This was followed by edema of the lids, chemosis and proptosis. On removal of the gauze these symptoms promptly disappeared. The same results were produced by injection of melted paraffin, although it was in the orbit proper, not beneath the periosteum.

In the table there are given examples of each type of pathology. Six cases cleared up with only conservative measures so the exact pathology was not determined.

Treatment aims at prevention of a central extension and cure of the orbital infection, as well as a cure of the causative sinusitis. Most standard texts and older articles advise surgery, an incision and search for an abscess and radical exenteration of the sinus. Drainage of an abscess seems advisable, but the difficulty is in knowing when pus is present as it may be deep and fluctuation not made out. If pus is not found beneath the periosteum it is not likely to be found in the orbit proper, and traumatism here, caused by searching for it, may be dangerous.

Simpson, in a recent article,¹ gives the views of Hajeck, Faulkner, Theisen, Porter, Coakley and Phelps, all of whom favor a radical external operation on the affected sinus. Simpson's own opinion is that radical exenteration of an acutely inflamed sinus is dangerous, whether done intranasally or externally. He does favor doing only an external drainage operation of the frontal or ethmoid, opening the sinus widely, and inserting a drainage tube.

Simple infraction of the middle turbinate has been reported to cause an escape of pus and rapid improvement in some cases.

When we consider the varied pathology in the orbit and the dangers of any surgery in these acute sinusitis cases, there is much

to recommend conservative measures. Chemotherapy, hot packs, therapeutic X-ray and local shrinking in the nose will be sufficient in many instances. Infants and patients whose case is due to scarlet fever have an especially good chance of recovery by these means.

Determination of the invading organism is important in the prognosis and treatment. Three patients (cases 8, 9, and 10 in the table) were given sulfanilamide and in the two due to *Streptococcus haemolyticus* the effect was prompt improvement. None of the cases of acute fulminating "swimming sinusitis" due to *staphylococcus* have been seen since the advent of sulfathiazole. It is these cases that are most serious and reports of the effect of sulfathiazole will be very interesting.

SUMMARY

1. There are several types of pathology that can cause the picture of orbital cellulitis.
2. Differentiation from a unilateral cavernous sinus thrombosis may be difficult or impossible.
3. Venous stasis is important in the production of the clinical picture.
4. Conservative measures will be sufficient for many of these cases.

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TABLE I

Case No.	Age Sex	Predisposing Cause	Symptoms	Sinus Involved	Bacteriology	Treatment	Course and Result
1.	15 yr. Male	Scarlet fever one week, Bilateral otitis media.	Temperature 101°, redness and edema of lids of right eye, chemosis, proptosis, limitation of motion.	X-ray, right pansinusitis.	Strep. haemolyticus.	Incision of subperiosteal abscess.	Later — zygomatic abscess and left mastoidectomy; osteomyelitis and sequestration from left humerus. In hospital two months.
2.	7 yr. Male	Sore throat, flu two weeks before.	Left eye closed, edema of lids, chemosis, slight proptosis, pain, pus left nostril, temperature 104 to 101°.	X-ray, left pansinusitis.	Nonhemolytic streptococcus.	Hot packs, local treatment to nose, "expectant."	Sepsis; positive blood culture; temperature 106 to 100°, normal temperature two weeks; swelling in frontal region, one week; final recovery, one month.
3.	16 yr. Female	Swimming in small lake.	Edema and redness of lids, proptosis right eye, limitation of motion, temperature 101.6°.	X-ray, right pansinusitis.	Staph. aureus.	Incision, evacuation of pus outside of periorbitum.	Three weeks; later — osteomyelitis, right frontal; extradural abscess, radical operation. Complete recovery.
4.	13 yr. Male	Swimming in pool.	Pain left eye, edema of lids, proptosis, chemosis, temperature 104 to 105°.	X-ray, left pansinusitis.	Staph. aureus.	Hot packs, local treatment to nose.	Meningitis; thrombosis superior sagittal; pansinusitis; death in five days.

TABLE I (Continued)

Case No.	Age Sex	Predisposing Cause	Symptoms	Sinus Involved	Bacteriology	Treatment	Course and Result
5.	8 mo. Male	Acute cold while in hospital two weeks after opening retropharyngeal abscess. Bilateral otitis media.	Temperature 103°, eye swollen shut, no fixation, moderate proptosis, chemosis.	Ethmoid?	Strep. haemolyticus.	Hot packs, local treatment to nose.	Temperature normal in three days; home in one week.
6.	30 yr. Female	Swimming in Lake Michigan. Cold.	Pain, swelling right eye, temperature 101°, proptosis, chemosis, limitation of motion.	X-ray, right sphenoid and ethmoid.	Staph. aureus and albus.	Hot packs, local treatment to nose.	Recovery in hospital, one week.
7.	23 yr. Male	Awoke with terrible pain in left eye. No cold or swimming.	Rapid progress, edema left eye, proptosis and fixation, temperature 101°.	Sinuses clear to X-ray.	Staph. aureus	Hot packs, X-ray therapy.	Death in five days. Post-mortem: meningitis, bilateral pansinusitis, thrombosis of cavernous sinus and internal carotid, purulent cellulitis of orbit.
8.	23 yr. Female	Swimming at Lake Okoboji.	Pain left eye, edema, proptosis, chemosis, temperature 103°.	Left pansinusitis.	Indefinite, mixed—anaerobic.	Hot packs, X-ray therapy, sulfanilamide.	Slow steady improvement to complete recovery in two weeks.

TABLE I (Continued)

Case No.	Age Sex	Predisposing Cause	Symptoms	Sinus Involved	Bacteriology	Treatment	Course and Result
9.	15 mo. Male	Cold, left otitis media.	Temperature 105.6°, proptosis, displacement down and out, lids closed.	Ethmoid?	Strep. haemolyticus.	X-ray therapy, sulfanilamide, hot packs, local treatment to nose, blood transfusion.	Temperature normal in two days, complete recovery in one week.
10	16 yr. Male	Ill three weeks with Cold, sore throat, slight rash.	Temperature 101°, edema of lids, closed right eye, chemosis, proptosis, limitation of motion.	X-ray, right pansinusitis.	Strep. haemolyticus.	Sulfanilamide, 20 cc. convalescent serum, local treatment to nose, hot packs.	Temperature normal, left hospital in eight days; later irrigation of antrum.

XII

COMPLICATIONS OF A PERITONSILLAR ABSCESS

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AND

OSCAR HIRSCH, M.D.

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A peritonsillar abscess ordinarily is not a serious matter, even though it may be the cause of severe pain. It is only when it breaks into the parapharyngeal space or is complicated by hemorrhage, septicemia, phlegmon of the neck, edema of the larynx, meningitis, brain abscess, or thrombosis of the cavernous sinus that it may become serious. However, most of these complications are relatively uncommon. The case herein reported is of especial interest because of its clinical sequence of events, its anatomical relationships, and the bacteriology involved. It represents the stay of the patient in the Boston City Hospital from March 16 to Dec. 19, 1939.

CASE REPORT

A 21-year-old married Italian-American woman in the eighth month of her third pregnancy entered the hospital on March 16 with a history of a sore throat for a week which eventuated, the night before entrance, in rupture within the mouth of pus and blood from an apparent left peritonsillar or parapharyngeal abscess. Improvement was only temporary; difficulty in swallowing and opening of the mouth, chilliness, and malaise brought her admission to the medical service with the diagnosis of ruptured pharyngeal abscess, bronchopneumonia, and eighth month pregnancy. A throat consultation noted swelling of the left side of the throat down to the hypopharynx, but with no place of definite softening or pointing. Sudden profuse hemorrhage of a cupful of blood on March 27, with four succeeding hemorrhages within a few days, necessitated ligature of the left external carotid artery through an external neck incision. The next morning the patient was delivered of an eight-month stillbirth, although the record described the fetal heart as heard on hospital entrance. There followed a stormy five-day period of a pneumonic process, or atelectasis, which subsided. On April 25 the throat service was again asked in consultation because of the persistence of left neck tenderness, sore throat, dysphagia, chilliness, and malaise. Per oral examination still offered no point of softening. Because of difficulty in raising the head, and because it was felt that there must be pus in the neck fascial planes, the neck was explored through the same incision used for the carotid ligature, where the tenderness seemed to be localized. Much bleeding was encountered, and pus was found just behind the lower edge of the left thyroid cartilage, posteriorly. The larynx at this time revealed the left false cord swollen and overlying the true cord, and the ventricle obliterated.

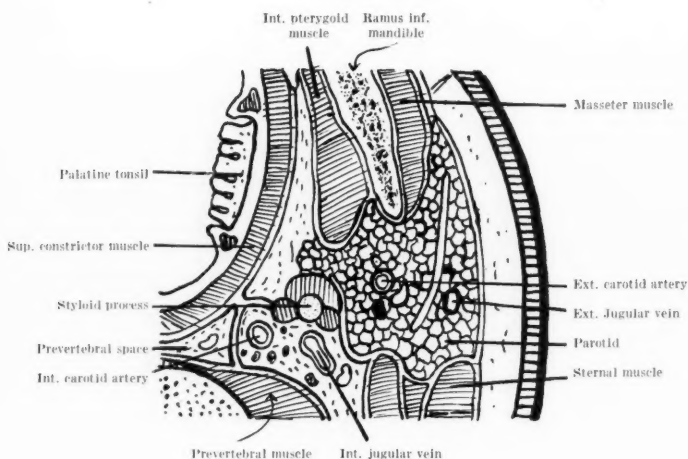


Fig. 1.—Showing close relationship of the great vessels to the tonsil and the pharynx.

It was evident that we were now dealing with a perichondritis of the thyroid cartilage. On May 13 a window was made in the left thyroid cartilage, the lower edge of which was necrotic and was removed, and a pocket of pus was evacuated from the left ventricle. It now appeared that a long, slow process of degeneration and repair was to be awaited, and because of the great amount of laryngeal obstruction present a tracheotomy was considered advisable and was accordingly carried out. All this time the patient's temperature was normal although chilliness, malaise, and headache were frequent symptoms. There was gradual improvement of the left side of the larynx, even though it developed that the right ventricle and false cord were becoming involved, until on July 19 it became advisable to investigate the right thyroid cartilage. A similar perichondritis and an abscess were found in the right ventricle. Healing was slow, and for about six weeks laryngeal obstruction was still too great for removal of the tracheotomy tube. On Sept. 12 a laryngofissure was done, with incision through the right ventricle, from which a small walled-off abscess was evacuated. From then on there was gradual improvement, until on Oct. 31 the tracheotomy tube was removed.

During the period when the perichondritis was active there developed, to the left of the manubrium of the sternum, at the costosternal margin, a tender area which on incision on July 10 yielded a few drams of pus, culture of which showed an almost pure culture of *Bacillus suispestifer*. This remained a draining, fistulous tract, healing very slowly. Gradually there developed, three inches lower down, a second abscess which on drainage on Nov. 28 yielded pus of a similar nature. After that the patient gradually improved, the sinuses closed, and on Dec. 19 she was discharged. On Nov. 23 cross agglutination with organisms of the paratyphoid bacillus and the two types of known *Bacillus suispestifer* of the mono- and diphasic

types showed definite agglutination reactions. During the time from entrance to discharge cultures from the throat had shown only mixed infections of diphtheroids, *Staphylococcus aureus*, and *Streptococcus hemolyticus*, with no predominant organism. It was only from the chest wound that the *Bacillus suipestifer* was isolated on Nov. 8 and was continually found until Dec. 13. On Dec. 18, before discharge, only *Staphylococcus aureus* was found. This case represents a series of complications following a peritonsillar abscess. In this case the abscess perforated into the parapharyngeal space, eroded a blood vessel, causing severe hemorrhage controlled only by tying the external carotid artery, and finally brought about perichondritis of the thyroid cartilage and costosternal abscesses which finally, on culture, yielded a pure culture of *Bacillus suipestifer*.

DISCUSSION

A peritonsillar abscess always originates in the loose connective tissue between the external surface of the tonsil and the superior pharyngeal constrictor, which is covered laterally by fascia. In this way a peritonsillar abscess presses the pharyngeal muscle, with its fascia, toward the parapharyngeal space. Because the muscle, with its accompanying fascia, is rather thin, and because of the numerous vascular communications between the tonsil and the parapharyngeal space, a peritonsillar abscess may easily find its way into the parapharyngeal space and can thus spread in all directions, producing complications.

SIGNS OF PARAPHARYNGEAL INVOLVEMENT

Clinical signs of such an expansion beyond the limits of the pharyngeal fascia are:

1. The peritonsillar swelling is not as prominent within the mouth as usually is the case.
2. There is present a painful infiltration of the submaxillary region and a painful lymphatic gland in the region of the mandibular angle.
3. The infiltration frequently appears behind the posterior pillar, causing a swelling parallel with this pillar, or is notable lower on the pharyngeal wall, and is best seen with the laryngeal mirror.

HEMORRHAGE

Sudden spontaneous hemorrhage in a case of peritonsillar abscess should be placed first among complications of such abscesses. The sources of such bleeding are the great vessels (external and internal carotids) and all the branches of the external carotid supplying the tonsils with a tonsillar artery. These are the descending

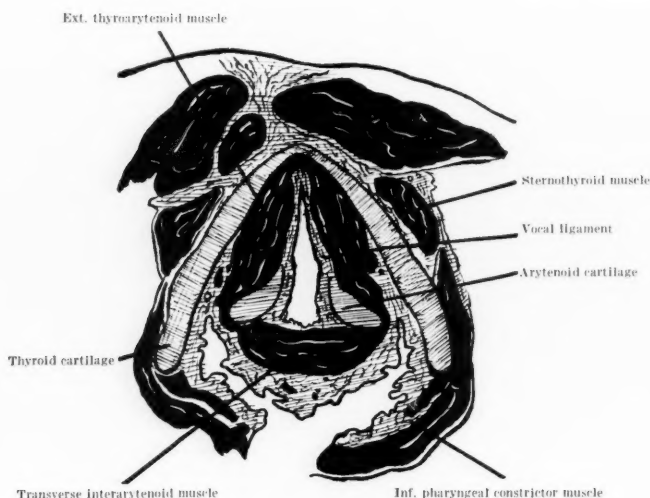


Fig. 2.—Horizontal section through the larynx at the level of the ligamentum vocalis.

palatine artery, the ascending palatine artery, the lingual artery, the external pharyngeal artery, and the external maxillary artery.

Bulatnikow¹ demonstrated that in anatomical specimens the position of the great vessels (carotid arteries) is definitely nearer to the pharyngeal wall and tonsils in adults than in children. Turning the head to either side brings the vessels closer to the side toward which the head is turned. The average distance between the internal carotid artery and the outer tonsillar wall is approximately 2 cm. Traction of the tonsil, depressing the tongue, and opening of the mouth do not alter this measurement, as is shown in Fig. 1. Likewise, any of the above-mentioned branches of the great vessels may be similarly in close relationship to the pharyngeal wall. For that reason, before operating on any pharyngeal abscess it may be wise to palpate the pharyngeal wall for pulsation of such a vessel. However, post-mortem examinations of patients who died of hemorrhage in relation to peritonsillar abscess have revealed that the source of bleeding was most frequently the internal carotid.

Salinger and Pearlman² reviewed 231 cases of bleeding in peritonsillar abscess perforating into the parapharyngeal space, and found

in these instances the carotid artery to be as close as 3 mm. to the posterior pillar, instead of 2 cm. as mentioned above as the normal anatomical relationship. Of these, 227 cases of bleeding were divided into six groups: (1) due to peritonsillar abscess; (2) due to peritonsillar abscess with parapharyngeal space involvement; (3) due to retropharyngeal abscess; (4) due to retropharyngeal abscess with parapharyngeal space involvement; (5) parapharyngeal abscess; (6) abscess of the neck; all of this last group involved the internal jugular vein.

Of these 227 cases where bleeding occurred, in 154 cases the vessels were not tied; 36 recovered (23 per cent); in 72 cases the vessels were tied; 46 recovered (65 per cent). Of the 72 cases in which the vessels were tied, in 18 cases the external carotid was tied; 11 recovered (61 per cent); in 54 cases the common carotid was tied; 36 recovered (66 per cent).

In 90 post-mortem unligated cases the vessel erosions found were 49 cases internal carotid, 4 cases external carotid, 14 cases internal maxillary, 9 cases common carotid, and 1 case transverse sinus erosion. In 85 cases a single hemorrhage was sufficient to cause sudden death.

Since this last paper was written by Salinger and Pearlman, a search of the literature showed 26 cases of hemorrhage caused by peritonsillar abscess. Of these cases, in one case death was due to bleeding from a vessel in the carotid gland. In one case there was bleeding from the mouth and external auditory meatus. Ligature of the external carotid and jugular vein was carried out; the patient died, but no post-mortem was done. In one case post-mortem revealed an arteriovenous aneurysm, with a spur between the carotid artery and jugular vein. The common carotid was ligated, but hemorrhage did not cease.

In 1 case death resulted from bleeding of the jugular vein.

In 3 cases bleeding ceased after external carotid ligation.

In 2 cases bleeding ceased after common carotid ligation; 1 patient did not survive.

In 9 cases bleeding came from the internal carotid; 2 of these cases were untreated.

In 7 cases internal carotid ligation was done. Of these cases, 1 patient developed permanent hemiplegia and another transient hemiplegia.

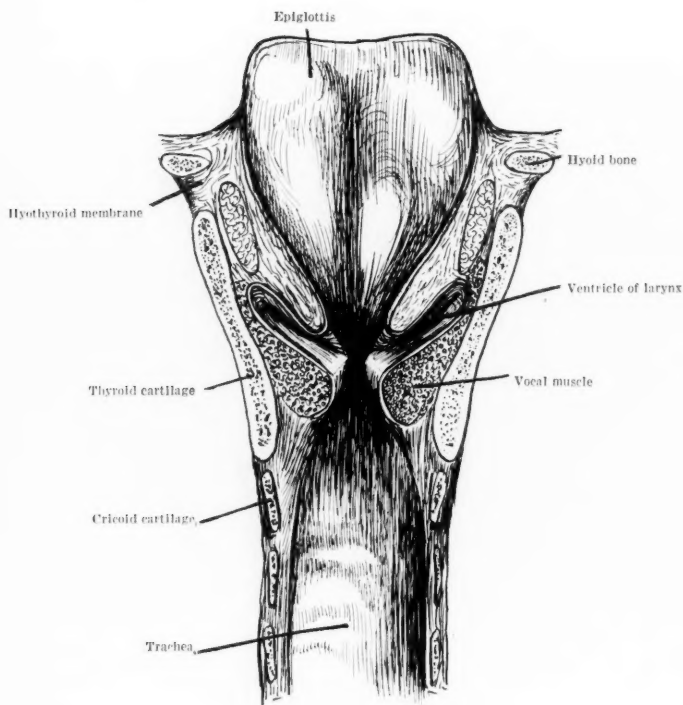


Fig. 3.—Frontal section through the larynx.

In 2 cases bleeding was said to be due to erosion of the carotid—external or internal not designated.

It is evident from these figures that hemorrhage occurs most frequently from erosion of the internal carotid.

In the diagnosis and treatment of parapharyngeal abscess the following signs must be considered as potential sources of danger: (1) spontaneous bleeding originating from a large vessel; (2) cases that do not recede after incision of the abscess; (3) hematoma of the neighboring tissues, with submucous discoloration, increasing pain and swelling, trismus, and pulsation in the peritonsillar region.

Under these conditions, exposure of the carotid artery is urgent. In a small number of cases an erosion of the external carotid may be

found and tied. If the erosion cannot easily be found and the situation is urgent, then ligation of the common carotid may be indicated, since a revision of the literature shows the internal carotid to be the most common source of bleeding. It is a frequent surgical experience that haste is necessary and isolation of the bleeding vessel is difficult, for which reason there may be definite indication for common carotid ligation. If the condition of the patient warrants and haste is not absolutely necessary, the external carotid may be tied first, with a loose tie about the common carotid, to be tied if bleeding recurs. When the common carotid is ligated, 28 per cent of the cases show brain complications, of which half are fatal. Under such grave conditions, where other factors are also present, only 10 to 15 per cent may be said to be due directly to ligation of the common carotid. There is much hesitancy about tying the common carotid because of the effect on the brain. However, a review of the literature shows that unligated cases bear a mortality of 77 per cent, whereas in cases where the common carotid is tied the mortality is only 10-15 per cent, of which only 28 per cent have brain complications. It is therefore wiser not to exaggerate the danger of tying this vessel. There should be no delay in tying the common carotid in urgent cases. Deep neck phlegmon rarely leads to erosion of the arteries, but rather to thrombophlebitis of the jugular vessel. Ligation under these conditions usually carries a bad prognosis, because of possible subsequent septicemia.

PERICHONDritis OF THE THYROID

One of the most infrequent complications of parapharyngeal abscess is perichondritis of the thyroid. In these cases the inflammation has spread down from the fascia of the superior pharyngeal constrictor to the thyroid cartilage on its internal surface, producing an internal perichondritis of the thyroid cartilage. The anatomical possibility of this is seen in Fig. 2. In the early stages of this condition the diagnosis could be made by noting the prolapse of the left sinus of Morgagni, and also clinically by the fact that the thyroid cartilage is tender and painful.

In order to explain the prolapse of the ventricle due to an internal-surface perichondritis, Fig. 3 presents a frontal view of the larynx, showing the lateral wall of the ventricle in close relation to the thyroid cartilage. Because the tissue in the ventricle is loose an inflammation of the thyroid cartilage causes a swelling and prolapse of the tissue, narrowing the lumen of the larynx. However, it is still necessary to explain the occurrence of such a rare condition as an internal perichondritis of the thyroid cartilage.

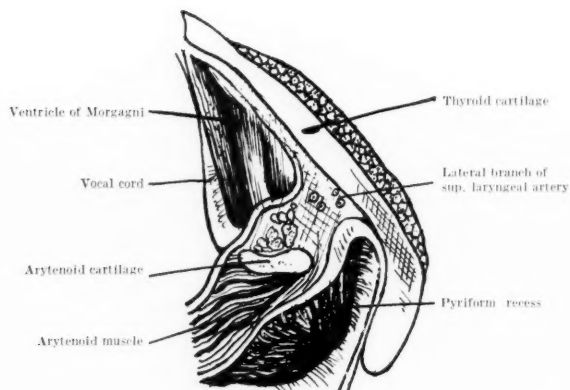


Fig. 4.—Horizontal section demonstrating the ventricle of Morgagni, from the floor of which a muscle-containing fold of mucous membrane arises. Dagger denotes point of entrance of branch of superior thyroid artery.

Perichondritis of the thyroid cartilage may be on the internal or external surface of the thyroid, although both are uncommon except in cases of carcinoma or gumma, which are not within the scope of this paper. External surface perichondritis develops during the course of acute infectious conditions, as tonsillitis or influenzal throat conditions, within a period of one or two weeks, or following trauma or knife wounds. In such conditions the symptoms are pain, fever, and swelling over the laryngeal and tracheal area, and difficulty in swallowing. The pain here is projected deeper and lower in the neck than in tonsillitis. No fluctuation is felt because the abscess is under the external muscles of the neck covering and inserted in the thyroid cartilage. A short adipose neck may be another source of difficulty in recognizing this abscess. Since the thyroid cartilage extends posteriorly to the pyriform sinus, swelling and edema also occur in the pyriform sinus region. Usually when there is an external surface perichondritis there is no hoarseness or dyspnea, but when internal surface perichondritis is also present there will be edema of the pyriform sinus, arytenoid and aryepiglottic folds, extending to the vocal cords.

The literature on this subject is very sparse. In recent literature seven cases of perichondritis of the thyroid cartilage are de-

scribed by Mayer,³ one case by Klestadt,¹⁰ and one case by Kernan and Schugt.⁴ Six of Mayer's cases were of external surface perichondritis, five were caused by influenza, and one was traumatic in origin, due to a splinter from a projectile. This seventh case was an internal surface perichondritis caused by excision of an intrinsic cancer. The external surface types of perichondritis were treated by external incision and drainage of the abscess. In only one case was laryngofissure used to find the abscess and remove the necrotic tissue of the thyroid cartilage.

Cartilage is much more resistant to sequestration than is bone, because of its lack of vascularity and the tight adherence of the perichondrium. It is only when the perichondrium is separated on both sides that sequestration of cartilage occurs. However, when there are areas of ossification in the cartilage, these areas, because of vascularization, are apt to sequestrate. In adults there is usually a partial ossification, so that the so-called perichondritis may be in fact a periostitis or osteomyelitis, and in these instances necrosis and sequestration more easily occur. In such instances an external surface perichondritis will not cease suppurating when incision is made unless curettage and removal of the necrotic areas are carried out. Cartilaginous sequestra are more infrequently found. Chiewitz⁵ examined 127 male and 105 female patients and found ossification present in all males over 20 years of age and in all females over 22 years of age.

The case described in this paper is one of pure internal surface perichondritis of the thyroid cartilage, originating from the parapharyngeal abscess. This internal surface perichondritis developed within the larynx in the region of the left ventricle. The pyriform sinus was not involved. This is noteworthy because the greater part of the internal surface of the thyroid forms the lateral boundary of the pyriform sinus. Because the parapharyngeal abscess was the source of the perichondritis one would expect the suppuration to follow the external surface of the thyroid cartilage (Fig. 2). In the case herein reported, although the external surface was tender it was absolutely not swollen; if present, swelling could have been felt and recognized, because the patient was thin. One can only explain this by assuming that there may have been a defect in the thyroid cartilage, which was the avenue of infection. Such defects in the thyroid cartilage are rather common. The superior laryngeal artery usually passes through the thyrohyoid membrane. In some cases this artery passes through a small hole in the thyroid cartilage itself.⁶ Such an anatomical variation may offer an avenue of infec-

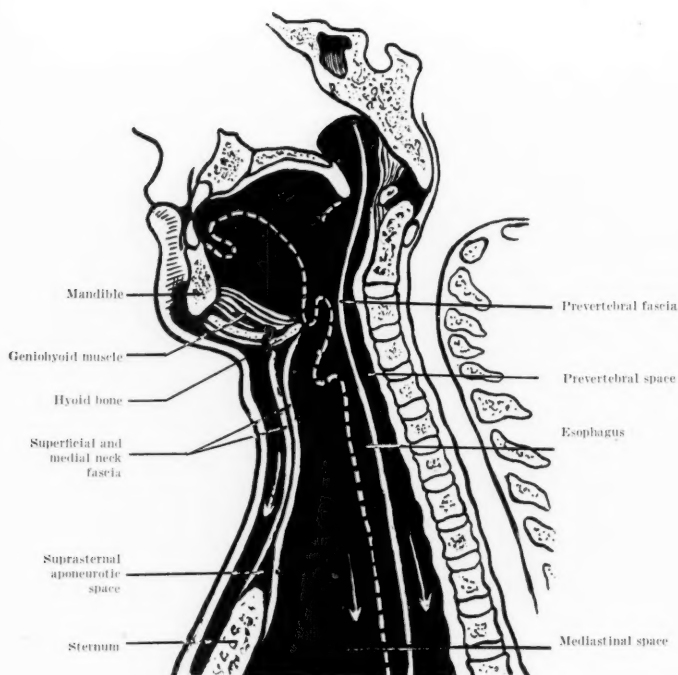


Fig. 5.—The aponeurotic suprasternal space, where infection follows over the anterior surface of the sternum.

tion. This vessel may have been the carrier of the infection in this case, also, for it gives off a lateral branch close to the internal surface of the thyroid cartilage in the region of the ventricle. Such an explanation agrees with the findings during our operation. After the tracheotomy, the operative procedure done to drain the abscess in the region of the left ventricle by a window through the cartilage, showed a defect in the cartilage, enlargement of this defect was all that was necessary. Because drainage proved insufficient, due to the progression of the infection along the inferior angle to the right side, it was deemed advisable to do a laryngofissure. This procedure was carried out, and with removal of granulations, an abscess containing 1 cc. of pus was uncovered.

The ensuing costosternal abscesses can be explained by the anatomical distribution of the fascia of the neck. The superficial fascia

of the neck continues as the medial fascial layer over the larynx and is inserted in the manubrium of the sternum, forming the supra-sternal aponeurotic space. Mayer also describes a case with a similar location of pus in the sternoclavicular region. His patient required resection of the medial portion of the clavicle. In our patient only incision and drainage were necessary.

A special point of great interest in this case was the finding of the *Bacillus suipestifer* in the abscess over the sternum. A study of this type of infection explains the slow development and progress of these successive abscesses from the parapharyngeal region to the sternum, covering a period of nine months. This organism frequently brings about such a slow and chronic form of infection.

The *Bacillus suipestifer* is a gram-negative motile organism, similar to the paratyphoid group, and was first described as the hog cholera bacillus by Salmon and Smith⁷ in 1885, and later named *Salmonella suipestifer*. In 1902 Longcope⁸ reported two cases of human infection, typhoid-like in character, first described as caused by the paracoln bacillus, but later identified with the hog cholera bacillus. Since then there have been several outbreaks of food poisoning due to this organism. Geographically, there are three recognized types: (1) the American type; (2) the Eastern type, *Bacillus paratyphosis*; (3) the European type, monophasic. Specific agglutination tests definitely identify them. Because of its prevalence around Baltimore, Harvey⁹ reported 21 cases, with an extensive review of the literature. He found two well-defined types of this infection: (1) an uncomplicated bacteremia, typhoid-like in character; (2) cases of pulmonary involvement.

The first type begins with sudden onset and then settles down to a typhoidal character. There are chills and temperature up to 103 to 104° for a few days, with anoxeria, nausea, and vomiting. More often there is diarrhea, but sometimes there is constipation. Generalized abdominal pain will be present, but no characteristic physical findings. It may act like a bloodstream infection and involve bones and joints with pyarthrosis. Chondritis and osteomyelitis are not unusual.

The pulmonary type may produce pneumonia, lobar or lobular. Pleurisy with effusion or empyema may occur. Search for the organism is necessary, or the cause will be unrecognized. The organism may be found in the septum.

Instances of *Salmonella suipestifer* have been reported complicating surgical procedures. Other tissues may be involved, including

the meninges, endocardium, and urinary tract. The blood picture is not characteristic. There may be a tendency to leucopenia, but with evidence of localizing signs there will be leucocytosis up to 10,000. The organism is a member of the same family group as the paratyphoid bacillus, and cross agglutination with these organisms may give confusing results. The organism may remain in the blood for a relatively long period, and is easily grown in culture media. It produces no specific pathologic lesion. Involvement of the spleen or liver may occur. Petechial hemorrhages and cloudy swelling of some of the viscera are common. It also occurs sporadically and without gastrointestinal symptoms. It frequently goes hand in hand with other diseases but usually has no great virulence in man, though it is severe in animals. In the epidemic form there may be a mortality as high as 40 to 60 per cent.

The direct relationship between the human infection and infected pigs has not been definitely established. In fact, more recent work seems to point to the belief that the real cause of hog cholera in this country and in Europe may be a filterable virus, and that the *Bacillus suispestifer* is a secondary invader or saprophyte. It has been found in association with gonococcic arthritis, ischiorectal abscess, rickets, mediastinal tuberculosis, pharyngitis due to beta-hemolytic streptococcus, and in degenerative conditions of the uterus. One case was reported after a bilateral antrotomy of the maxillary antra. Culture of the sinuses was negative, but the urine was positive for the *suispestifer* organism. When it is typhoidal in character it may suggest appendicitis, and lead to a needless operative procedure. Conditions resultant from it are slow in healing, and blood cultures may be positive for the organism for months. One case was reported positive for two years. The low-grade character of the infection is characteristic, as it was in the case here reported. There were comparatively few periods of material temperature in the patient's entire hospital stay.

CONCLUSION

A case of parapharyngeal abscess is reported, complicating pregnancy. Rupture of the abscess, with pneumonic signs, brought the patient into the hospital. Later severe hemorrhage necessitated ligation of the left external carotid artery, following which abortion was precipitated and a stillbirth resulted. Internal surface perichondritis, first of the left side and then of the right side of the thyroid cartilage, ensued. Both plates of the thyroid cartilage became affected, necessitating several operative procedures, including tracheotomy and later, laryngofissure. Sternal abscesses developed which,

after incision, showed that the patient had gone through a bacteremia due to infection with the *Bacillus suispestifer*, a not entirely uncommon infection, although not known to most of us.

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XIII

TREATMENT OF OTOMYCOSIS

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Otomycosis presents a rather formidable problem to the dispensary and hospital physician of the Canal Zone. It is prevalent at all times of the year, largely because the relative humidity is constantly high and the temperature variations are small.

The symptoms are frequently those of severe pain, discharge, swelling, and insomnia, rather than the milder symptoms of itching, discharge, and deafness as noted in many localities of the United States.

The large number of patients suffering from otomycosis, seen daily in the Eye and Ear Clinic at Ft. Randolph, prompted me to evaluate the many drugs and methods advocated for the treatment of this condition. Before attempting this study, the literature on the subject was considered, and the methods employed in the local clinics were observed. A preliminary period of four months was utilized in order to become more familiar with various types of otomycosis, checking the clinical findings with microscopic study. Cases used in the study were carefully selected from the out-patient service.

The external ear canal resembles a dark, warm, moist test tube lined with skin, containing varying amounts of wax and debris. This presents an ideal field for the growth of fungi. The skin is firmly bound to the canal walls. Thus, an infection of the skin usually results in a diffuse, painful inflammation. The outer third of the canal contains hair follicles, sebaceous and ceruminous glands, which at times present a portal of entry for secondary invading bacteria, resulting in furuncles.

Otomycosis can be manifested by diffuse otitis externa, dry or moist eczema, and furunculosis. Some cases of chronic otorrhea will be found to be due to secondary invasion of fungi. Studies in this series showed a varying degree of cellulitis of the external ear and adjacent skin in 40 per cent of the cases, accounting for the severity of the symptoms experienced.

When the fungi go through the superficial layers of the skin, inflammation results. The epithelium becomes wet, exfoliates, and mixes with fungus debris. This produces not only a favorable culture for fungi, but bacteria as well, particularly the *Staphylococcus aureus*. The infection may result in complete destruction of the skin with invasion of the perichondrium. It may invade the middle ear, producing suppurative otitis media with its many potential complications. It may go beyond the ear and involve the skin, lymphatics, or deep structures of the neck. Stokes¹ describes otomycosis as having a first stage manifested by mild symptoms, hyperemia of the canal and drum, and a moldy appearance; and a second stage manifested by an exfoliated canal, debris, diffuse inflammation with varying amounts of involvement of adjacent structures.

The usual fungi found in the external ear are of the genus *Aspergillus*; rarely *Penicillium* is found. Dodge² lists 35 species of *Aspergillus*, most of which have been found in the ear. Minchew and his associates³ found the *Aspergillus* present in almost all of the positive cases. The fungus debris varies in appearance. It may appear mottled gray like macerated blotting paper, white, like absorbent cotton, black, brown, green, or reddish brown. A varying amount of wax and pus may be present also.

In considering therapeutics, careful study was made of the work of McBurney and Searcy,⁴ who made extensive studies in vitro and vivo of the effect of 69 substances upon the growth of *Aspergilli* and *Staphylococcus aureus* and compared the results with those obtained from the use of 5 per cent phenol according to the method of Koppescaar. Alcohol in all dilutions was found entirely ineffective in the prevention of growth of *Aspergilli*. Alcohol-boric and alcohol-salicylic solutions were found to be nearly as ineffective. These substances were found to aid by cleaning and drying the canal. Alcohol-salicylic solution also possessed some exfoliative properties. Alcohol-boric solution was found to be only a mild bacteriostatic agent. Preparations containing iodine were most effective against *Staphylococcus aureus*. Preparations containing 2 per cent thymol were 2.5 times more effective against *Aspergilli* and 1.5 times more effective against *Staphylococcus aureus* than those without thymol. Castelloni's solution was effective against both *Aspergilli* and *Staphylococcus aureus*.

In the treatment of this series of cases an attempt was made to attain the four objectives stressed by Gill:⁵ (1) to cleanse mechanically the external canal from the meatus to the drum head as care-

fully as possible, avoiding any trauma or maceration of the skin; (2) to reduce local inflammation and allay pain; (3) to limit sporulation; and (4) to leave the parts in such a condition as to prevent recurrence. Medication was usually employed on a cotton wick for periods of 12 to 24 hours during the first 2 or 3 days. Following this, medication was employed in the form of "drops" or local application, depending upon the progress of the case. Simple cases were treated from 7 to 14 days.

TABLE I
90 CASES STUDIED DURING NOVEMBER AND DECEMBER, 1940,
AND JANUARY AND FEBRUARY, 1941

Agent	Number of Cases	Number of Treatments	Percentage Cured	Difference Between Control and Agent	$\sqrt{\frac{P \times Q}{n}}$	$\sqrt{\frac{P_1 \times Q_1}{n_1}}$	Significant
Control (Mechanical cleansing)	11	44	55%	-----	-----	-----	-----
Cresatin	9	34	89%	34%	18%		Yes
Thymol, 2 per cent, in cresatin	11	40	100%	45%	15%		Yes
Alcohol-boric solution	8	35	62%	7%	23%		No
Castelloni's solution	8	28	87%	32%	19%		Yes
Icthyol- glycerine	10	41	30%	-25%	-----		No
Thymol, 2 per cent, in alcohol and tincture merthiolate	8	33	62%	7%	23%		No
Cresol, 2 per cent, in glycerine	7	25	71%	16%	23%		No(?)
Cresatin, 20 per cent, magnesium sulfate and glycerine	9	37	67%	12%	24%		No
Iodine, 1 per cent, in boric acid, pulverized	9	35	78%	23%	15%		No(?)

In evaluating the efficiency of a substance it was necessary to employ a control. In the first series of 90 cases (Table I) 11 selected cases were used. The débris was removed thoroughly with minimum injury to the canal, using 95 per cent alcohol where necessary. The canal was then dried. If counter-pressure was needed to prevent obstruction of the canal, a small wick of cotton was inserted. The alcohol, as shown by McBurney and Searcy,¹ did not act as a fungicide, but as a cleaning and drying agent.

Merely comparing an agent with the control upon a percentage basis was not considered sufficient. It was necessary, therefore, to determine how large a difference between the two groups was likely to occur by chance. In order to accomplish this the standard error of a difference between proportions was needed. The standard error of the difference between the two proportions according to Hill¹⁶ is

$$\text{shown by: } \sqrt{\frac{P \times Q}{n} + \frac{P_1 \times Q_1}{n_1}}.$$

The control group is represented by: $\frac{P \times Q}{n}$

The group treated by a specific agent is represented by: $\frac{P_1 \times Q_1}{n_1}$

The percentage of cures is represented by P ; the percentage of failures by Q ; and the number of cases in the group by n .

The standard error of difference was compared to the actual difference found in the study. Any amount which was materially less than twice the standard error was not considered significant, in as much as it was considered to be within the realm of chance. To illustrate this the agent, 2 per cent thymol in cresatin, when compared to the control, showed a difference in cures of 45 per cent. The standard error in this case was 15 per cent (Table I). Twice 15 per cent equals 30 per cent, an amount which is less than the actual findings of 45 per cent. It is safe to assume then that the high percentage of cures was due principally to the agent used and not to mere chance. On the other hand, the group treated by alcohol-boric solution showed only a difference of 7 per cent when compared to the control group. The standard error was found to be 23 per cent, indicating that the slight difference in cures was not significant, in as much as such difference could easily result from chance (Table I).

After completing the first 90 cases changes were made. The following agents, alcohol-boric, ichthyol-glycerine, thymol 2 per cent

TABLE II

125 CASES STUDIED DURING MARCH, APRIL, MAY, AND JUNE, 1941

Agent	Number of Cases	Number of Treatments	Percentage Cured	Difference Between Control and Agent	$\sqrt{\frac{P \times Q}{n} + \frac{P_1 \times Q_1}{n_1}}$	Significant
Control (Mechanical cleansing)	15	102	47%	-----	-----	-----
Cresatin	23	109	79%	32%	15%	Yes
Thymol, 1 per cent, in cresatin	22	93	95%	48%	14%	Yes
Castelloni's solution	21	85	69%	22%	16%	No(?)
Cresol, 1 per cent, in glycerine	24	115	50%	3%	17%	No
Iodine, 1 per cent, thymol, 1 per cent, in boric acid, pulverized	20	79	67%	20%	17%	No(?)

in alcohol-tincture merthiolate, and cresatin 20 per cent in magnesium sulfate-glycerine were not found to be significant, and so were discarded. The 2 per cent thymol in cresatin produced considerable burning and at times pain when used in a raw canal. Following the conclusions of Minchew and his associates,³ the thymol was reduced to 1 per cent. This controlled the burning and pain. The 2 per cent cresol was questionable, so it was carried into the second series (Table II). The cresol was reduced to 1 per cent because of occasional aggravation of acute inflammation when employed in 2 per cent strength. The 1 per cent iodine in boric acid powder was not significant. It was continued into the second series to determine if addition of 1 per cent thymol would materially improve this agent as a fungicide.

In general the results of the second series were not as good as the first, in as much as the cases were studied during the dry season when the atmosphere was hot and sultry. Profuse sweating led to an increase in moisture in the canal. This was particularly noticeable in the control group.

SUMMARY

Before proper results can be obtained with any substance, the débris must be removed from the canal gently and thoroughly. Attention must be paid to the anterior acute angle. If removal cannot be effected mechanically, a gentle lavage with warm water usually will suffice. Medication is best applied on a wick for the first two or three days, leaving the wick for periods of twelve to twenty-four hours. When the wick is employed the medication is kept in constant contact with the infected surfaces, and undue swelling and obstruction of the canal are prevented.

Careful consideration was given to the work of McBurney and Searcy,⁴ Gill,⁵ Gill,⁷ Stokes,¹ Minchew and co-workers,³ Whalen,⁸ and Lederman,⁹ before selecting agents for study. Many of the time-honored agents used in the tropics were found valueless during the preliminary four-month period. A few of the better ones were brought into the study.

Thymol, 2 per cent, in cresatin proved to be highly efficient as a fungicide. It did produce considerable burning and discomfort when used in raw canals. Thymol, 1 per cent, in cresatin was found to be equally as efficient as a fungicide. It did not produce burning, but proved to be a good local anesthetic and drying agent similar to cresatin alone. After the wick had remained twelve to twenty-four hours the canal walls were white, dry, and exfoliative. Much of the dry skin and débris could be removed with an applicator, thus expelling many spores. If the solution proved too strong, it was diluted with equal parts of olive oil. Occasionally the drops, used after wicks had been discontinued, were diluted.

Cresatin alone proved to be excellent, but not as effective as 1 per cent thymol in cresatin.

The result from Castelloni's solution was fair when it was used carefully. If used too frequently, it either unduly irritated the canal or caused drying of the skin with resulting pain.

Insufflation of 1 per cent iodine and 1 per cent thymol in boric-acid powder produced fair results. It possessed some value as a medication to be used in resistant cases or in cases of chronic otitis media where an associated fungus infection is known or suspected to exist.

The time honored alcohol-boric solution was no better than the control. In general alcohol preparations proved to be painful and at times increased the inflammation.

The time honored ichthol-glycerine possessed value in early treatment of highly inflamed canals. It was found to be poor as a fungicide.

Glycerine preparations usually macerated the canal walls. Occasionally they aggravated a secondary bacterial infection which proved worse than the original condition.

CONCLUSIONS

1. A study of 215 cases of otomycosis was conducted in the Panama Canal Zone.

2. Thymol, 1 per cent, in cresatin (metacresylacetate) was found to be highly efficient as an agent for treatment of otomycosis.

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XIV

BODY FLUID AS THE CRITERION FOR SOLUTIONS FOR NASAL TREATMENT

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The reports of Fabricant¹ on the pH of nasal secretion confirm previous conclusions as to the variability of this factor, but the inferences and recommendations relating to nasal treatment do not appear to be fully justified. As the subject deals with fundamentals of pharmacology and is of undoubted importance, further discussion is desirable.

In treatment of upper respiratory infection it has become customary to use large quantities of solution intranasally. In head-low postural technic² the nasal membrane literally is immersed. As the solution is aqueous, miscibility with the surface film on the epithelium is virtually certain and intimate relationship is established between the solution and the epithelial cells. The cell walls are permeable to drugs, certain chemicals, and water, and are known to be adversely affected by numerous unnatural environmental factors.³ Hence, compatibility between solution and nasal membrane has become a primary necessity.

For some years the author⁴ has recommended that the criteria for solutions for nasal treatment be the physical characteristics of body fluids. These characteristics are the basis of all cellular structure and all tissue function. They are constant, well understood, and capable of duplication by simple means. If solution instilled into the nasal fossæ has the same physical properties as the fluid of the adjacent tissues, no known injury can occur blamable to the vehicle.

Gamble⁵ has described the physical structure of body fluids, cellular and extracellular, in terms of osmotic pressure, pH, and temperature. For the purposes of this discussion we add another factor, freedom from toxic substances. In health there is remarkable constancy in these values throughout all body tissues, with sensitive mechanisms for maintaining this constancy.

A solution for intranasal use designed according to known physiologic principles consists of a useful but locally nontoxic drug in a vehicle compatible with tissue fluid. The solution is characterized by isotonicity, pH 7.4, freedom from toxic substances, and at time of instillation body temperature. The vehicle functions only as the carrier of the drug without itself being the cause either of action or reaction.

Quite different from tissue fluid is the material called nasal secretion. All reported work indicates that nasal secretion is wholly variable both in composition and in physical values, and a moment's consideration will show this to be understandable. It arises as secretion, excretion, and exfoliation from the entire surface of the ocular and nasal tracts. It consists of serous and mucoid fluids with inclusions of epithelial cells, white blood cells, bacteria and their toxins, and foreign substances of inhalant origin. It is subjected to air currents of varying temperature, humidity, and CO_2 content, and is modified by autolysis, decomposition, fermentation, and the products of growth and death of pathogenic and saprophytic bacteria. Being lifeless material it has no means of maintaining the standards of the surrounding tissues, and its composition and characteristics at any given instant are unpredictable, being constantly changed by factors in its environment.

A typical example of the variability of nasal secretion is illustrated by Fabricant's report¹ that scanty secretion has a relatively high content of H ions, whereas abundant secretion, as in infection or allergy, has a low content. It is possible that this difference is due simply to relative absorption of CO_2 from expired air. And variability in other factors is equally common. Osmotic pressure varies according to extent of evaporation. Temperature varies with each inhalation. Composition varies widely in its proportions of serous and mucoid fluids, cellular, bacterial, and inhalant inclusions, and bacterial and autolytic toxic substances.

So, while the most notable characteristic of tissue fluid is stability, the most notable features of nasal secretion are instability and variability.

These circumstances indicate toleration by nasal mucosa of deviations from normal inevitable in its environment, and are evidence of efficient defense. There is little justification, however, for deducing that certain phases in the variation are purposeful and optimum and hence proper criteria for solutions for intranasal use. It is unsound to prefer some phase of the unstable, variable structure

of a lifeless extrusion to the stable, invariable standard of living tissue. Yet, Fabricant has recommended this, and his thesis even has received some degree of official recognition.

Our concern is to maintain the structure of the fluid of the nasal tissues. Compatibility between solution and tissue fluid guarantees this through identity of physical characteristics, whereas a differential between the two media could change values within superficial cells and thereby impair function. As our concern is the integrity of the tissue, our standard is the physical structure of the fluid of the tissue, not the fluid of nasal secretion, or of nasal or sinus discharge, or of any other entity.

The use of vasoconstrictor solutions in head-low posture has led to a few observations relative to compatibility that are of clinical interest. Membrane shrunken with a physiologic solution of ephedrine or one of the related synthetic drugs usually assumes the normal appearance of bright, rich redness. Shrinkage is attained fairly rapidly and with no tickle, sting, odor, or other intranasal sensation. Considering the sensitivity of the area this seems a fair test of compatibility of a solution miscible with the surface film of nasal fluid. Duration of shrinkage depends on the pathology, but is relatively prolonged. As a therapeutic effect this is both desirable and comprehensible in the treatment of nasal infection.

But mucosal shrinkage of maximal duration requires a locally nontoxic drug and a solution compatible with tissue fluid. While slight deviations may be compensated for, considerable errors hasten return of congestion and edema by acting as sources of irritation.

Intranasal awareness of vehicular errors differs according to direction as well as extent of deviation. Solution of low temperature causes less sensation and is less unpleasant than temperature slightly above normal. Less intranasal discomfort is caused by pH above 7.4 than by comparable deviation below. Hypertonicity causes less complaint than comparable hypotonicity. Intolerance of antiseptics and preservatives is striking, all having been found to cause intranasal discomfort of a degree such as to discourage a second application.

But although these facts may be accepted because readily demonstrable, one can but speculate as to the reasons. In the case of pH it is possible that CO_2 absorption increases the H ions in the one instance toward normal, in the other farther away. It is possible that dilution of hypertonic fluid by withdrawal of water from the

tissue may be accompanied by replacement sufficiently rapid to minimize cellular damage, whereas water absorbed by the tissue from hypotonic fluid may be passed along too slowly, resulting in injury to colloidal structure and to cell wall. Epithelial damage reported from various antiseptics³ leaves no doubt that their use is as unphysiologic as are errors of pH or of tonicity. Even so, Gompertz and Michael⁶ have found the antiseptic content of commercial vasoconstrictor solutions insufficient to preserve their sterility. More potent arguments against the use of antiseptics would scarcely seem to be needed, yet the custom probably will be difficult to eradicate.

SUMMARY

Nasal mucous membrane presents problems in treatment different from other body surfaces, the situation being more nearly comparable to intravenous and intraspinal therapy. Only aseptic solution should be used, and preservation of sterility should be inherent in the method of administration. Antiseptics should be avoided for reasons of intranasal discomfort and cellular damage. Treatment solution should be compatible with tissue fluid, which means that the physical characteristics of solution and tissue fluid should be identical. Only thus can cellular injury be avoided from differences in physical structure beyond the ability of the tissue to compensate. As our concern is the integrity of the tissue, our standard is the physical structure of tissue fluid.

Complete accord with the author's views has been expressed by Dr. Eric Ogden, Department of Physiology, University of California, and by Dr. Paul Michael and Dr. Gertrude Moore, pathologists, Oakland, Calif.

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ESTROGENIC SUBSTANCE IN THE TREATMENT
OF ATROPHIC RHINITIS*

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While atrophic rhinitis is not one of the most common entities seen in the practice of otolaryngology, it has merited a great deal of attention, because, up until the last few years, it has been one of the least responsive to any of the advocated forms of therapy. Innumerable methods of treatment for this condition have been described, varying from conservative application of various medications to stimulate the nasal mucosa, to radical and extensive surgical procedures. In the majority of cases, whether radical or conservative methods were used, the results were unsatisfactory.

During the past five years there have been several articles describing the use of estrogenic substances in the treatment of atrophic rhinitis. Mortimer and his associates in speculating as to the etiology of atrophic rhinitis suggest a decreased secretion of the gonadotrophic hormone of the pituitary at puberty which only repeated hormone assays can prove.

They also postulate a lack of response of the mucous membrane to the normal estrin circulating in the blood stream. Eagle and his associates made biopsies before and after estrin therapy in 14 cases. They brought to light the fact that there were no definitely striking changes in the histologic picture. There were suggestive alterations which they noted; namely, minimal increase in the mucous glands and increased looseness of the connective tissue. There were 22 cases in all treated by them and 21 were clinically improved. Soskin and Bernheimer did not obtain favorable results using estrin therapy in cases of atrophic rhinitis. Their exact methods of treatment are not described. Since they thought that the action of estrin in atrophic rhinitis was due only to the hyperemia it induced they have substituted prostigmine methylsulfate 1:2000. They recommend that this be used as a nasal spray, 0.25 cc., four times daily, together with daily nasal irrigation. Noteworthy improvement is claimed in their

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14 cases treated in this manner. In some cases a "definite space reduction in the nasal vaults" was observed. They report later the successful treatment of 20 cases in all. Strachan was unsuccessful in the treatment of atrophic rhinitis in children.

For a year and a half we have been treating a series of 20 cases of atrophic rhinitis with estrogenic substance. With our method of treatment the nose is first cleansed of all crusts. These are detached with the aid of a bayonet forceps and a nasal spray (Skillern's) after which the patient blows his nose, evacuating the loosened crusts. The nasal cavities are then packed with large cotton pledgets which have been moistened with estrin. These pledgets are made as large as possible and have two threads about three inches long attached to them. The pledgets are placed in the region of the middle meatus with the strings extending into the anterior nares for easy removal by the patient. The patient is instructed to leave the packs in place as long as possible. With the first few treatments, he can retain this packing for only a few hours, but later most patients can keep the packing in place for as long as two or three days without discomfort. Patients are treated in this manner twice weekly. After the packing is withdrawn they are instructed to use a warm alkaline nasal irrigation each day until they return for the subsequent packing. In addition they are given an estrin spray to use twice daily. This spray is regulated to deliver 0.25 cc. of estrogenic substance into each nostril. After improvement is noted the alkaline irrigations are discontinued and the estrogenic substance sprayed into the nose only once a day.

Improvement was noted within a few weeks after the onset of therapy. The crusts began to dissolve and the mucosa became somewhat more pink in color. However, we noticed no apparent increase in the size of the turbinates; and the airway, to all intents and purposes, was not decreased in size. Most patients noted an increased quantity of nasal mucus together with a disappearance of pharyngeal symptoms. The number of patients complaining of atrophic rhinitis associated with pharyngitis was striking in this small series. Headache was commonly complained of during treatment. This is probably attributable to the large size of the nasal packs.

Epistaxis was noted in only one female. Tinnitus was present in several cases. None of the patients noticed a decrease of the tinnitus, and two patients were definitely worse while undergoing treatment. The similarity of atrophic rhinitis to atrophic vaginitis has been described. Notable in this series was the frequency of associated menstrual disturbances in the females.

There is no question among the patients as to their improvement and almost all wish to continue the therapy. Males seem to improve as quickly as females. It appeared that recent cases responded somewhat more quickly.

CONCLUSION

Estrogenic substances are a useful group of therapeutic aids in the treatment of atrophic rhinitis. We have had the opportunity of comparing cases under former methods of therapy and now treated with estrin, and the results with estrin are striking. Twenty cases were treated with noteworthy alleviation of symptoms in all. It is our opinion that estrin therapy is merely palliative and not curative but should be given a very high rating in our therapeutic armamentarium for the treatment of atrophic rhinitis.

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TABLE I

Age	Duration	Sinusitis	Ozena	Pharyn- gitis	Sex	Results
24	2 years	No	Yes	Yes	M.	Fair
31	1½ years	Yes	No	Yes	F.	Excellent
39	4 years	No	No	Yes	F.	Excellent
22	6 years	No	No	Yes	F.	Excellent
20	3 years	Yes	Yes	Yes	F.	Excellent
34	4 years	No	No	No	F.	Excellent
20	1 year	No	No	No	F.	Excellent
47	1½ years	No	No	Yes	M.	Excellent
35	2 years	No	No	Yes	F.	Excellent
40	10 years	No	No	No	M.	Fair
53	5 years	Yes	Yes	Yes	F.	Excellent
24	4 years	No	No	Yes	F.	Excellent
46	8 years	No	No	Yes	F.	Excellent
31	2 years	Yes	No	Yes	M.	Excellent
25	4 years	No	No	Yes	F.	Excellent
32	½ year	No	No	Yes	F.	Excellent
20	1 year	No	No	No	F.	Excellent
41	7 years	Yes	Yes	Yes	F.	Excellent
18	2 years	No	No	Yes	F.	Excellent
26	5 years	No	No	Yes	F.	Excellent

XVI

ALLERGY IN RELATION TO OTOLARYNGOLOGY

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About ten or fifteen years ago the role of allergy in nasal infections began to be appreciated, the possible relationship between infections, allergy and their combination to be analyzed, and the part that each plays in a particular case to be established. The reason for the compilation of the statistical data here shown is to suggest a routine practice of attacking the problem.

I. A review of 3,657 consecutive cases in an eye, ear, nose and throat practice:

A. Eye complaints	1,665	45%
B. Ear complaints	692	19%
C. Throat complaints	580	16%
D. Nasal complaints	720	20%

II. Review of the 720 nasal cases:

A. Allergic nasal cases	140	19.4%
B. Other than allergic nasal cases	580	80.6%
C. The allergic nasal cases are of total cases reviewed		3.7%

III. Review of the allergic cases:

A. Showing an eosinophilia of	
1. Over 50%	26 cases
2. 10% to 50%	34 cases
B. Showing no eosinophilia (1-10%) but proven allergic	28 cases
C. No smears taken	52 cases

IV. Review of the types of allergens to which these cases were skin sensitive:

A. Inhalants	57	40.7%
B. Food and contacts	7	5.0%
C. Both inhalants and foods and contacts	76	54.3%

V. Review of results:

A. Satisfactory by allergic management alone (avoidance and desensitization)	67	47%
B. Satisfactory by allergic management plus local treatment	38	27%
C. Satisfactory by allergic management plus surgical management	30	21.7%
D. Failures	5	3.5%

VI. Experiences with mucosal testing—review of fifty cases of perennial allergy:

A. Showing an eosinophilia	About 50%
B. Showing no eosinophilia but proven allergic	34%
C. No smears taken	16%

Of the allergens to which these patients were skin sensitive, 26.2 per cent were inhalants and 73.8 per cent were foods and contacts, of those tested with mucosal tests inhalants were responsible in 40 per cent, foods and contacts in 60 per cent. Complete correlation between dermal and intradermal tests existed in only 8 per cent of the cases; between mucosal and intradermal tests in only 2 per cent.

Among the inhalants detected with the mucosal tests there were, in order of frequency: dust, feathers, wool, orris, kapok, tobacco, animal hair; and of the foods: wheat, milk, eggs, beef, oranges, pork and chocolate.

Only 46 per cent of the positive intradermal tests could be checked as being verified by mucosal tests and 12 per cent as reproducing the symptoms which had originally brought the patient into the office.

Recording of positive reactions with the mucosal tests are according to the severity of the reaction and the duplication of the symptoms bringing the patient into the office. It has been found that in eliminating the more severely reacting allergens patients can in most cases tolerate the minor offenders. All reactions are recorded, and allergies not pertaining to otolaryngology are referred to the family physician. Mucosal tests are never performed in cases of pregnancy.

Symptoms produced with mucosal tests are edema of the turbinates, rhinorrhea, sneezing, itching of the nose, itching of the roof of the mouth, headaches (usually unilateral), blurring of vision, pain in the eyes, scintillating scotoma, dizziness, vertigo, some loss of hearing (mostly subjective), tinnitus, earache, pain in the mastoid region, pain and fullness in the sinuses, Sluder's syndrome, neurotic symptoms (mild and irrational), rheumatic pains, pharyngitis, edema in the throat, coughing, asthma, indigestion, nausea, irregular menstruation, uterine pains, edema of the gums, dyspnea, increase in saliva, muscular weakness, hypertension, drowsiness, backache, fever, hot flashes, hives (usually on the side of positive reaction) and leucopenia, which will check closely with the leucopenia produced by ingestion.

DETERMINATION OF ALLERGY IN A GIVEN CASE

The diagnosis depends on a history of sneezing, nasal blocking, frequent mucoid to watery discharge, itching (especially in the morning), some inherited allergic disturbance, and intermittence of symptoms. The mucous membrane of the nose is usually edematous, pale, with or without polyps. If there is an acute inflammation of a nose with an allergic background, the paleness is lost but the edematous character of the inflamed mucous membrane frequently makes one suspect the presence of allergy. The cytologic study of the nasal secretions frequently helps in determining the analysis of a case. Nasal smears are taken preferably from the middle meatus, stained with Hansel's¹ eosin-methylene-blue and examined for eosinophils. This is not done in cases of allergy due to parasitic infections and in known drug addicts. If they are present, it is quite conclusive evidence of an allergic factor. However, when an infection has

supervened, the secretions are thin or purulent and one may find a preponderance of neutrophil cells. In such cases or when no eosinophils are found, repeated daily examination of smears or antrum washings will reveal them. The nasal smears from an allergic nose of the vasomotor-rhinitis type may have a preponderance of eosinophilic cells, but in the presence of an infection one finds almost 100 per cent neutrophils,² that is, the eosinophil cells may be difficult to find when stained with Wright's stain and when using an oil immersion lens. As the infection clears, the neutrophils drop off and the eosinophils become easier to find on the slide. In such cases it is sometimes necessary to repeat nasal smears painstakingly for many days before eosinophils are discovered.

We have considered the presence of 7 to 10 per cent eosinophils or of scattered clumps as indicative of allergy, although even in an extremely sensitive individual they may not appear in the smear. Eosinophils in the nasal secretion come from infiltration of the nasal mucosa. They are present in the asthmatic patient's sputum and in the secretions from the eyes, intestines, or vagina when these are the seat of allergic disturbance. They usually indicate inhalant or ingestion allergy when found in the nasal secretion.

In cases of polyposis if there is an allergic factor present and it can be determined, the recurrence of polypi is minimized by adding allergic management to the removal of the polypi. This has been so satisfactory that we usually make smears and often remove a single polyp for biopsy before removing obstructive nasal polypi.

MANAGEMENT

If it is decided that a given patient has a nasal allergy and as many clues as possible have been obtained from his history, he is then skin-tested by the scratch method and rechecked intradermally or mucosally. The list of positives is then gone over and the major ones are eliminated from his environment. When this cannot be done, an attempt is made to make him hyposensitive to the most important ones. Great care must be taken not to give too large doses of the allergen, and they should be given over a long period of time to render the individual hyposensitive. The use of air filters, dust-proof covers on pillows and mattresses, diet lists in which the patient records every mouthful of food variety taken and his symptoms, elimination diets as described by Rowe as a basis for ruling out offending foods, must be taken with increase in diet as indicated.

We have thought that we were helped by leucopenic index studies on the basic foods. The patient comes to the laboratory after 12 hours of fasting, having taken in the preceding 24 hours some of the food for which he is to be tested, such as milk, wheat and eggs, and is then given a quantity of this food after a leucocyte count is taken. Instead of a leucocytosis during the next 20 to 40 minutes he usually develops a leucopenia. This food, then, is kept off his diet in spite of any skin-test reaction previously made.

ALLERGIC MANAGEMENT PLUS SURGERY

Hansel has recently stated that he found it necessary to do intranasal and sinus operations in only 25 out of 220 cases of nasal allergy. This statistical proportion has not been our experience. It has been necessary to do a great deal more surgery than this figure indicates. However, when we consider that Hansel is an authority on nasal allergy and a large percentage of this type of case comes to him these figures are justifiable. Dean⁶ recommends correction of nasal deformities and pathology when indicated, by the following methods:

1. Submucous resection.
2. Cautery or submucous diathermy.
3. Scarification of turbinates.
4. Removal of polypi.
5. Removal of infected adenoids and tonsils.
6. Establishing of drainage of infected sinuses when necessary.
7. Ionization in chronic vasomotor rhinitis not due to allergy.

In our own cases analyzed it was necessary to combine surgical management in 20 per cent of them. This includes the patients with noses full of polypi, with irreversible hypertrophies of long standing, with allergy plus sinus infection (particularly hyperplastic ethmoiditis and purulent antra from apical tooth infections), and with large posterior tips on the inferior turbinates. The disappearance of symptoms with the correction of these deformities is greatly increased by also avoiding irritating allergens whenever found.

It is a common observation that sometimes allergic manifestations, particularly asthma and hay fever, develop after nose and throat operations, especially tonsillectomies. These are only the pre-

cipitation of potential allergies by breaking down the integrity of the nose and throat mucous membrane. The exactly opposite experience is frequently encountered, and we believe that this is due to the removal of the offending factor in a bacterial allergy.

In the use of ionization in nasal allergy we have had only little experience. In a few cases where there was no improvement with hyposensitization and in cases where the symptoms of seasonal allergy were well-advanced at the first examination and there was not sufficient time for desensitization, this method of treatment has been tried and found satisfactory in about 50 per cent of the cases. In few more than a dozen cases over a three-year period we have not encountered the destructive and erosive atrophic changes that are spoken about by many authors. Nearly all of these seasonal cases are relieved for the season, and we have attempted to make them hyposensitive the following year, so that ionization has not been repeated the second year. Two biopsies of turbinates were made, and they showed a loss of ciliated epithelium and an increase in the fibrosis of the basal layers.³ One of us (Linton) in testing by the mucosal method just before ionization and again from eleven days to one year after ionization found the sensitivity of the nasal mucous membrane unchanged.

Applications of trichloroacetic acid to the hypertrophies of the inferior turbinate are frequently made, and the "tightening-up" of the mucous membranes has given a fair percentage of temporary relief. These escharotic processes decrease the absorptive power of the mucous membrane and in inhalant cases relieve the symptoms greatly, at least temporarily. We have never had the obstructive symptoms of acute sinusitis follow these cauterizations.

MEDICAL TREATMENT

For the control of local symptoms medically, the shrinking of the nasal mucous membrane and the use of ointment, containing a combination of ephedrine and cocaine, produce a good deal of symptomatic relief except in cases of drug sensitivity. The intravenous injections of calcium gluconate and sodium iodide frequently repeated, and the giving of ephedrine or propadrin will quiet the acute symptoms temporarily, at least to give one time to work out the etiological factors.

Ramirez states,⁴ "Just one word about the importance of endocrine glands and of vitamins in bacterial asthma and allergy. These are phases which one hesitates to discuss because of the pres-

ent lack of knowledge. I believe that there is a definite relation of endocrine dysfunction and vitamin deficiency not only to asthma but to allergy in general. I do not think any one gland or deficiency of any one vitamin is solely responsible. Any gland or combination of glands can be an important factor affecting the underlying fundamental mechanism of hypersensitiveness." (Girls frequently become allergic on reaching puberty.) "I believe that this phase of allergy indirectly may involve a strong hereditary influence and determine the shock tissue."

In nasal cases in which no allergen can be found, and the patient is proven to have a low basal metabolic rate, small doses of thyroid have relieved the nasal symptoms completely. Linton⁵ has been able to produce sinusitis consistently in 90 per cent of white rabbits by sensitizing the rabbits generally and locally in the maxillary sinuses. He found the infection could be prolonged as desired by administering the allergen every few days. On discontinuing the allergen the infection cleared up in one to two weeks. There is reason to believe from clinical experience that the same procedure is applicable to the human and would explain Hansel's low percentage of surgery in allergic individuals.

It is our opinion that a very close liaison between the otolaryngologist and the allergist is desirable and that it is very important that a careful evaluation of the nasal changes be observed during any treatment of allergy.

CONCLUSIONS

1. The frequency of allergy as a complicating factor in otorhinolaryngology should be appreciated.
2. Search for eosinophiles while recommended is not reliable unless search is extended over a period of time.
3. Allergic investigation and management is an important therapeutic adjunct to surgical and medical management.
4. Definite relationship exists between allergy and infection.
5. Symptoms of allergy are shown and can be reproduced by a safe and reliable test.
6. Conclusive proof of the allergic background of any individual case can only be established by painstaking investigation and therapeutic trial.

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XVII

HISTOPATHOLOGIC CHANGES OF THE TEMPORAL BONE IN PAGET'S DISEASE

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Otologic examinations of Paget's disease of the skull reveal an impairment of hearing in nearly all cases. At first there appears to be a purely conductive deafness, rarely an affection of the inner ear, but frequently there is manifested a combination of both impairments.

In examining the vestibular apparatus normal or subnormal values are frequently found. Complete dysfunction of the vestibular apparatus is exceptional in contradistinction to the cochlear part of the labyrinth, which is always found to be affected adversely. These observations of the changes of the labyrinthine and perilabyrinthine bone led many writers to believe that Paget's disease of the temporal bone could be compared with otosclerosis. Because the bony process of otosclerosis is analagous to that found in Paget's disease, some investigators even went so far as to conclude that otosclerosis was a retarded form of Paget's disease.

Although it seems that the pathologic picture of the bony labyrinth is known, the problem of the etiology still remains obscure for Paget's disease as well as for otosclerosis. Almost all pathologists agree that in any pathology of the bone, the end results depend upon the action of osteoblasts and osteoclasts. The etiology of these two diseases is still not clear. Several theories were advanced and later discarded. The vascular and traumatic theories were put aside for the hormonal theory, and this in turn is now being replaced by the newer fermentative theory. In reference to this subject the studies emphasizing the participation of the parathyroid gland and the experiments on the growing rabbit bone by means of bone ferments should be mentioned. They were made by Robison at the London Lister Institute and verified by Zawisch-Ossenitz. Also well known is the supposition of Brunner, who together with Looser found an "inflammatory character," or an irritative process in osteitis fibrosa. This assumption was made, mainly due to the fact that some effusion

could be disclosed in the labyrinthine canal and to the presence of a few perivascular infiltrations in the pathologic marrow.

The number of histologically examined temporal bones in Paget's disease, including the series of Anson and Wilson, is still relatively small. The changes of the labyrinthine capsule in previously examined cases were not always progressive enough to be compared favorably with the findings of recent pathologic knowledge on this matter.

On this occasion, for example, the fact should be pointed out, that until the findings of E. Freund, the periosteal participation of the bone in Paget's disease was strictly denied by the few otologists interested in this problem.

I would like to report three new cases of Paget's disease of the temporal bone, which seem to reveal new facts because of the peculiar extension of the pathological process.

In Case 1, the temporal bone was involved in a man, 67 years old, who for 28 years had been treated for Paget's disease in several departments of the Allgemeines Krankenhaus in Vienna. His hearing was also checked because of impairment.

In the last five years of his life the patient observed that his head grew larger, forming a vault in the frontal region of his face, and that his height suffered a loss due to progressive bowing of his legs. In the spring of 1930 he developed intestinal symptoms with repeated attacks of hematemesis. In the fall of the same year the patient was again admitted to the hospital because of recurrent gastric hemorrhages, and a severe heart attack caused his death two months later.

The ear findings in the last eight years of his life were a thickening of the right drum with marked cicatrices and a retraction of the left tympanic membrane. At the beginning of his impaired hearing there was a middle ear affection combined with a slight degree of high tone impairment of both ears and with a prolonged bone conduction particularly on the right. The tuning fork examination revealed the following at that particular time: Weber, indefinite; Rinne, negative on both ears; Schwabach, slightly prolonged on the right and less on the left. C-1, definitely shortened on the right and less on the left; C-4, shortened on both sides; whispered voice, A.D. 1 meter; A.S. 3 to 4 meters; conversational voice, A.D. 3 M., A.S. 6 M.; Gelle test, positive on both sides.

After catheter inflation hearing improved on both sides. The examination in the last year of his life showed an extremely diminished hearing and a marked fall of the high tones on both sides.

The whispered voice was heard only ad concham and conversational voice was only 0.5 M. The vestibular apparatus was examined by calorization; the minimal caloric method did not show any reaction; then after introducing 100 c.c. of cold water at 17° C., both eyes showed a typical rotatory nystagmus of 30 and 34 seconds' duration, respectively.

Post-mortem examination showed a 155 cm. long male emaciated and pale. The bony skull was somewhat vaulted in the frontal area. The lower extremities were bowed. The ordinary cut, executed with a saw through the cranium, showed many fissures after using a sprinkler instrument to separate the calvaria. The skull appeared disproportionately thick. In the frontal region and around the occipital pole, the bone was 1 cm. thick. All parts of the bone cut easily with a knife. The bony prominentia of the base of the skull were extraordinarily thickened. The sella turcica was elevated and towered over both the anterior and posterior processes. The clavicles were thickened; the ribs normal. The cortex of the femur was widened to 1 cm. and eburnized; the bone itself was heavy and therefore very difficult to cut. The tibial cortex was also enlarged but, nevertheless, the spongy structure could be recognized. The bone marrow of the femur was red, that of the tibia and fibula fatty and yellowish.

The left lung was completely adherent to the wall of the thorax. Cross section of the left lung showed it to be filled with fluid. The right lung was similarly affected. The pericardium was completely adherent to the heart itself. The heart was small, about the size of a man's fist. The myocardium was flabby and reddish brown in color. Calcium deposits were found in the tissue of the mitral ring, semi-lunar valves, and in the septal membrane.

In the peritoneal cavity there was present a clear, slightly yellow fluid. The intestinal serosa appeared to be thickened by connective tissue, which contained many engorged vessels.

The liver was reduced in size (22 cm. by 15 cm. by 6 cm.) and had a hobnail appearance. The individual knobs were yellow to brown in color, while the irregular notches between the elevations were reddish. On the border between the two lobes the liver showed a slight, smooth elevation, which was sharply defined against the adjoining areas and which shown through the liver capsule as a reddish color. A cross section of the liver was greatly distorted; the individual lobes differed in size and were surrounded by a gray-white

tissue. Below the elevation on the surface there was a red tumor, microscopically recognized as cavernous tissue.

The spleen was somewhat enlarged, its capsule thickened. The trabecular system was well outlined and the follicular tissues more shadow-like and of a gray-red color.

The normal-sized kidneys had a normal capsule and a 0.5 cm. cortex. The cortex was of a yellow-red color like that of the renal surface. The pyramids appeared pale and the vessels friable.

In the esophagus there was a white thickening of the mucous membrane and the veins could be seen shining through. At the junction of the stomach and esophagus there was an ulcer present.

In the stomach and intestines coagulated blood was found. The pancreas and the other ductless glands appeared normal. The pathological-anatomical diagnosis was as follows: Cirrhosis of the liver; chronic enlarged spleen; recent hemorrhage of the gastrointestinal tract; erosion of esophageal varices; ascitic chronic adhesive pleurisy; adhesive pericarditis; arteriosclerosis of the aorta; atheromatous changes in the mitral valves; osteitis deformans of the skull, femurs, and tibias.

The X-ray examination of the frontal section of the base of the skull showing both petrous pyramids revealed patchy areas of structural changes in the bone. Those somewhat rarified areas of bone, millet sized, were dispersed throughout both pyramidal apices, the basilar bone and in the border between the clivus and the condyloideal part. The pyramidal configuration appeared normal. The labyrinthine bony capsule showed a reduction of calcium but no narrowing of the capsule itself.

Under low power in histologic sections the entire pyramid was seen to be composed of new bone. These new bone formations were seen around the cochlea, the semicircular canals, and the mastoid as well. The modiolus, the spiral laminae, and the bone surrounding the maculae cribosae remained unchanged.

The newly formed bone appeared somewhat spongy and consisted partly of small lamellar systems instead of the old labyrinthine capsule (Fig. 1). The mosaic appearance was due to the fact that the newly formed bone was rapidly laid down in a haphazard manner and as the absorption and the formation of new bone took place, the usual orderly configuration of the cemental lines was distorted and produced, therefore, a grotesque mosaic pattern.

In the examination of a series of vertical sections which were usually stained with hematoxylin-eosin and also comparing those stained by Van Gieson's method, the apex of the petrous bone was seen to be composed of new bone. There was not a trace of the old lamellar bone left around the eustachian tube, the carotid canal or the canal around the tensor muscle.

The newly formed bone extended here to both cranial fossae, middle and posterior, and consisted mainly of very small bony beams of a rosy or light blue color which were in most part connected with each other. These bony beams were interspersed with and interrupted by irregular arcuate, innumerable thin, blue lines. Between these thin blue, so-called cementum lines irregularly placed and mostly polygon-shaped bone corpuscles could be found. These bone corpuscles appeared very small and shrunken in the center of rebuilt beam, but they became enlarged and succulent at the margins. The marrow spaces of this spongy bone contained a varied degree of fibrous tissue, which also contained sporadically placed fat cells and showed a rich vascularization in the vicinity of an active process. From the fibrous marrow a recent destruction of the newly built bone by multinuclear giant cells could be observed in the apex. Simultaneously a new bone formation was seen to take place through the epitheloid marrow cells arranged in layers at the margin of the new bone and containing very distinct nuclei. These produced relatively large bands of rosy stained osteoid.

In some areas of the newly formed bone around the eustachian tube, individual lamellar bony systems with pretty irregular lines of cementum could be shown. Apparently they were formed here around a remaining vessel of the former bone.

The tubal cavity itself was of normal width and its mucosa with the epithelial lining was intact. The submucosal connective tissue, shaped like a plug, extended in some places into the fibrous marrow spaces so that there was a fusion with the opened marrow tissue. The same bony changes could be found in the rarified canal of the tensor muscle. Near the tympanal orifice the tensor canal appeared widened through circular rarefaction and the marrow spaces often reached the perimiseal sheets of the muscle. The muscular fibers appeared thinner and were sometimes displaced by connective tissue as well as by fat cells. In this area the fallopian canal was located in its sharp turn next to the geniculate ganglion and was also completely surrounded by the pathologic bone tissue. The ganglion itself lay partly in a fibrous cavity and was dorsally covered by the dural membrane, which showed in this particular area a great many

enlarged vessels. The rebuilt bone around the carotid canal did not show any visible changes in the walls of the vessel itself.

The bony walls of the middle ear consisted throughout of new bone. The mucous membrane was thickened everywhere and the subepithelial tissue was demarcated by a distinct blue line from the reconstructed bone. Here and there a small rosy osteoidal band was attached to the blue line and covered with flat cells, originating from the submucosal tissue, while the surface of the bone, directed toward the marrow, was rebuilt in the typical manner with relatively large osteoidal arrangements. The promontory wall was completely replaced by new bone, with the exception of small remains of the old capsule. The marrow spaces were mostly filled with fat marrow, however, even from here a rebuilding of bone had taken place in some areas.

The bony frame of the stapedial niche was likewise rebuilt to the anterior and lower portion, where the original cartilage and connective tissue still existed. The newly formed bone reached the thinned cartilage of the oval window in some places and a greater fat marrow area showed a notched blue line of demarcation from the cartilage. The annular stapedial ligament was unchanged, but the posterior space of the niche was occupied by a mucosal cyst filled with hyaline masses.

The somewhat thickened secondary tympanic membrane was partly attached to the old labyrinthine capsule medially and its mucosal covering contained several elongated cystic spaces. At the bottom of the niche there was a scanty layer of serous fluid without any cellular elements.

The tegmental plate of the middle ear and its continuation above the antrum consisted also of the newly formed mosaic bone with many acute processes. The small cellular spaces in the bone, as well as the tympanic cavity and the antrum itself, were traversed by a great number of connective tissue bands, which appeared partly calcified. In the network of these adhesions there were cystic spaces outlined by a flat epithelium and filled throughout with hyaline globuli.

The bone of the hypotympanic wall appeared thinned out and the adjacent jugular bulb enlarged. The subendothelial layer of the bulbar vessel was considerably thicker and in many places lay beside the fibrous marrow.

In these environs the wall of the bulbar vessel showed large areas of calcification which are partly granular and partly sheetlike

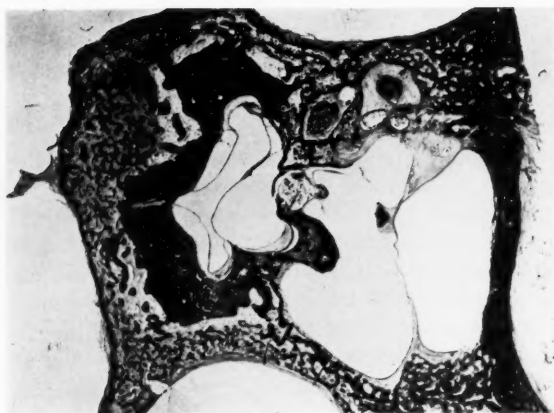


Fig. 1.—Vertical section through the vestibulum, middle ear, and external canal, showing progression of the newly rebuilt bone against the labyrinthine capsule.

approximating the endothelial linings. The lumen of the vessel itself appeared empty. The drum membrane was thickened and appeared slightly folded in its anterior part. The triangular attachment of the membrane at the newly formed bone was particularly broadened on the upper and posterior part, where a diffuse calcification of the membrane had taken place. In the direction toward the antrum a large cystic dilatation could be seen in the extended stroma of the membrane which communicates with the other cysts of the middle ear.

The chain of ossicles was free from the building of the bone, yet in the body of the incus there was a larger fibrous marrow space, extending to the cartilaginous lining. The short process of the incus lay imbedded in a connective tissue area, which had several cysts. In this part of the antrum the origin of the stapedial muscle at the pyramidal eminentia appeared medially and was surrounded by a very thin ring of the old bone. The muscle itself with its tendon and few ramifications of the nerve appeared normal. The descending facial nerve and the vessels in this region were completely surrounded by the newly formed bone of the mastoid process.

The bony external canal appeared slightly narrowed by a bulging of the posterior wall. Both the tympanic and squamous portion were completely reconstructed. The fibrous marrow had penetrated into

the subcutis at several points and thus had created passages into the dense connective tissue. On the other side apart from these marrow spaces could be found areas of an earlier rebuilt bone with new osteoid. On the small osteidal bands, layers of flat osteoblasts were present, originating from the connective tissue of the subcutis or arising from the periosteum respectively.

The examination of the internal auditory canal showed a thickening of the bone rebuilt there, particularly in the superior region. From the dura of the posterior fossa this boundary area was outlined by a partly calcified zone of connective tissue. The bone directed toward the lumen of the canal was compact in its entirety and consisted of irregular and narrow haversian systems, which still enclosed some fragments of the old labyrinthine capsule. Toward the glial sheet of the eighth nerve this partly lamellated older bone and the newly rebuilt bone were separated by various large blue lines. The deeper situated marrow spaces perforated here and there into the glia of the nerve and the cells had begun the work of reconstruction again from the inside of the canal. Also the intact glial tissue had participated in forming new bone, but the new margins were, of course, a great deal smaller compared with those built by the fibrous marrow.

Chiefly near the division of the nerve, its sheath contained innumerable spherical psammonous insets of various degrees. The nerve fibers and the ganglionic cells in the canal appeared almost subnormal, with the exception of the usual post-mortem changes. (Fig. 2.)

The cochlear capsule, as mentioned above, was almost completely replaced by a new bone as far as the modiolus. Remnants of the old perichondrial layer could not be established anymore, but a greater remainder of the enchondral capsule with its interglobular spaces was preserved medially toward the eustachian tube. It was a wedge-shaped piece, separated by a curved fissure from the new bone. The new rebuilt substitute was largely composed of a compact lamellar mosaic bone; however, spongy mosaic formations reached the endothelium of the cochlea, sporadically. This newly formed bone which replaced the labyrinth was almost entirely solid without any marrow spaces, but was interspersed by numerous blue, outlined, narrowed, perivascular spaces. This new bone showed a distinct blue stained and arcuate line of demarcation from the old labyrinthine bone. The kind of bone absorption observed in the lamellar structures of the mastoid or in the perichondrial layers could hardly be found here. The gaps were eroded and filled with a surplus of osteoid tissue.

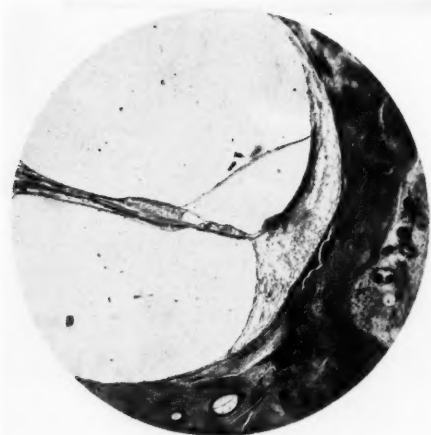


Fig. 2.—Section through the basal turn of the right cochlea showing the humplike progression of the new rebuilding bone.

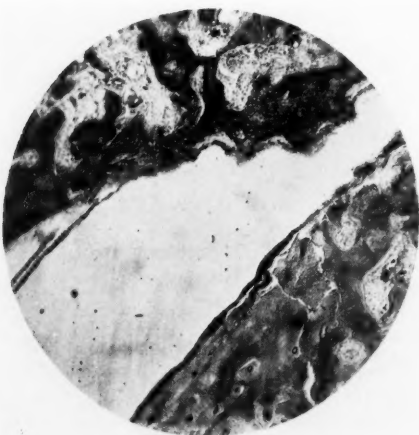


Fig. 3.—Section through the right upper semicircular canal. Bony resorptions reach the lumen of the canal.

The old labyrinthine and the newly built lamellar bone, as well as the lamellar-less plexus-like bone, bordered close to each other. Instead of the above-mentioned blue-stained demarcation line there could be found at the contact a very small slit, occasionally showing bony cells of both kinds.

The old labyrinthine capsule appeared red at these points of contact, but somewhat less deeply stained. Only at the points where the newly formed encroaching bone opened the vascular spaces did they also participate in the reconstructing process.

The perivascular spaces and the well-confined, dark blue-stained vascular mantles were the only union between the two kinds of bone and it seemed that the finger-like progression of the new bone was highly related to the arcuate arrangement of the vessels in this area. Also, the advanced bony resorptions reaching the endothelial layers likely depended on the previous vascular channels.

The well-preserved modiolus was separated by a small fissure from the new invading bone, which appeared denser and of a deeper blue color at the border. The canaliculi of the axis and those of the spiral lamina appeared wide and straight; only at the fundus, where the nerve fibers entered the lamina cribrosa, was there a slight narrowing of some bony canaliculi which were caused by small osteoidal formations. The cells of the spiral ganglion appeared well formed and filled up Rosenthal's canal; even the nerve fibers and their course in the spiral lamina were within normal limits. In the area of the vestibulum, as well as in the semicircular canals only fragments of the old labyrinthine bone could be found. The new supplementary bone enclosed only a few interglobular spaces. Around the cochlea the new bone was compact, mostly lamellar in type, and the few spongy spreads at the periphery were sparsely supplied with fibrous marrow. With a few exceptions this new bone reached the lumina of the vestibular system everywhere. It led to a narrowing of the clearing in the area of the upper semicircular canal just below the upper border of the petrous portion.

In these advanced areas some flatly expanded spaces of various sizes due to bony resorption could be seen below the endothelium of the canal. The spaces were filled with a loose marrow tissue and separated from one another by thin bony spicula, forming a point and giving the appearance of a festoon on the inner surface of the canal (Fig. 3).

At the junction of the old and new labyrinthine bone within the vestibulum the condition was the same as in the cochlea. Here



Fig. 4.—Vertical section through the right pyramid showing almost complete reconstruction of the entire bone and distinct deformation of the facial canal.

also could be found the humplike new bone growing forward against the canal system with the above-described changes.

In spite of the expansion of the new bony process into the inner cavities of the labyrinth, its membranous contents appeared relatively normal. The spiral ligament of the cochlea was somewhat loose, the capillary vessels of the stria and the vas prominens were slightly engorged, but the ligamental tissue itself was not pathologic. The basilar membrane together with Corti's organ and Reissner's membrane were in normal position and showed the usual post-mortem changes. In the upper coil, Reissner's membrane appeared partly adjacent to the tectorial membrane.

The sacculus and utriculus and the maculae lying in the proper positions were just as little changed as the endolymphatic and perilymphatic spaces.

Through the almost totally rebuilt pyramid the endolymphatic sac and duct coursed to the posterior fossa in normal relation to the sigmoidal sinus and the inner acoustic canal. A calcified layer of the connective tissue separated the duct from the new bone. In the lumen of the duct several spherical calcified bodies could be found.

The cochlear aqueduct, too, showed old bony remnants at the very beginning of the basal coil, but in its later caudad course it appeared to be encircled by the new bone.

Throughout the entire labyrinthine capsule small fissures could be demonstrated; they were partly bound to the endosteal layer itself and partly passed the old labyrinthine and the newly rebuilt bone. Some of the fissures were empty and others contained fine fibers, but no cells were present inside the lumen.

The dura mater appeared normal over both surfaces of the pyramid and only above the petrosal sinus, and at the points where the subdural tissue immersed deeper into the reconstructed bone did it seem thicker. At these points the dura was impregnated with large deposits of calcium and separated from the underlying bone by a blue line. At the places where the blue markings were missing the subdural tissue merged into the fibrous marrow and rebuilt the bone from there again. Underneath the dura at the minute bony spicules, very narrow ribbons of osteoid appeared sporadically. They were lined with a flat row of osteoblasts. The osteoid ribbons seemed to be independent of the invaded marrow, which developed an active process of reconstruction on the opposite side of the bone, forming large osteoidal bands.

The mastoid consisted completely of a spongy mosaic bone, where the actual process of reconstruction from the fibrous marrow was marked in an especially sharp manner. There were no traces of pneumatization and only a subantral space lined with irregular cystic tissue corresponded with a former greater complexity of cells.

In the sections of the left pyramid there were only slight differences of pathology. With the exception of old bony remains of a minor degree around the labyrinthine nucleus there was a new bone formation. This was spongy in character and carried marrow spaces partly filled with fibrous and fatty marrow. It replaced the old bone around the tube, the wall of the carotid artery, and the canal of the tensor muscle. The bone of the posterior and inferior pyramid wall appeared thin. A larger space filled with lymphoid marrow occupied a greater portion of the spongy bone. Often mixed with fatty marrow it gave rise to a stirring reconstruction with giant-cell resorption of the bone. Frequently a type of inner new bone formation originating from the perivascular space together with an apposition and absorption on the outer surface was derived from the lymphoid or fibrous surroundings and could be observed in a single bony beam.

The bone changes in the apex were analogous to those of a similar area on the right side. Also here the fibers of the marrow invaded the submucosa of the tube, the canal of the tensor, and the

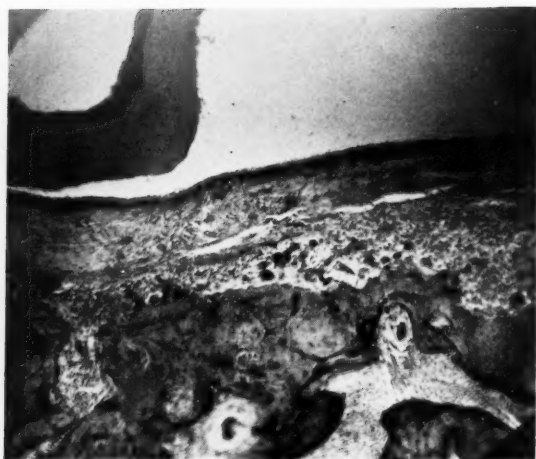


Fig. 5.—Inflammation of the tubal mucosa and violent destruction of the newly rebuilt bony canal.

bony wall of the carotid. The carotid artery itself showed, as contrasted to the right side, diffuse medial calcifications. The tubal lumen was outlined with a well-preserved epithelium and contained a slight amount of rosy secretion.

In the medial sections of the pyramid, where the carotid artery, the tube, the medial portion of the acoustic canal, and the basal cochlear turn were placed, the bony wall was thickened around the acoustic nerve and the canal itself was narrowed. Here the above-mentioned lymphoid zone encircled the cochlea after destroying its perichondrial layer and recasting the remainder of the old labyrinth. It also contacted the already reconstructed labyrinthine bone. The latter, being more red stained, grew in a humplike manner toward the old labyrinthine capsule. In a stereoscopic view at the border of the old and new bones some small fissures filled with undefined pink tissue and detached osteocytic bodies could be found. In other places of this area the vessels of the old capsule expanded into the new bone, whereas the blue sheaths of the vessels disappeared or remained very thin. The lumina of these vessels were still filled with red blood cells. These assumed the nutritional supply for a time.

The enchondral layer was well preserved in the area of the middle cochlear turn. The newly formed bone approached in an

identical way toward the labyrinthine capsule. At the blue line of demarcation were minute fissures without any reaction of the bone, or the osteocytes of the new bone appeared in more dense formation near the slits, which retained some of the cartilaginous remains.

In the area of the apical coil there was an almost complete absorption of the old labyrinthine bone and only the endosteal layer remained untouched in a small zone.

The left modiolus appeared in the same relation as the right one, and the bony changes around the acoustic and facial nerves, as well as the nerves themselves with their ganglia, were identical to those of the opposite side.

The inner structures of the cochlea also showed equal proportions and relatively well preserved nerve end-organs.

With the exception of the perichondrial layer, one could find the old labyrinthine bone in the vestibular region in good condition. Certain areas containing interosseal globuli were preserved in the upper frame of the oval window in the angle between the facial and horizontal canals and at some places near the ampullae and semicircular canals.

The newly formed compact bone lay between the old capsular remainders and reached the labyrinthine lumen here and there. Being almost entirely without any marrow spaces the new bone enclosed several vascular lumina, which appeared to be surrounded by a blue line of demarcation. The narrow perivascular sheaths contained only a few cells of connective tissue.

At the places where the new bone was in contact with the lumen of the semicircular canal, the endothelial lining was separated by a flat marrow space, which was filled with loose connective tissue.

Only in a very small area of the upper canal did the new bone seem lacerated and the adjacent perilymphatic space showed some flocculent cloudiness, rosy stained and without cells.

The utricle and saccule, as well as the nervine membranous structures of the canals, showed the normal agonal and post-mortem changes.

The changes in the bony walls of the middle ear, the mastoid process, and the external bony canal wall were identical with those on the right side.

The mucous membrane of the middle ear showed multiple cystic formations which filled the epitympanic space, the fenestral niches,

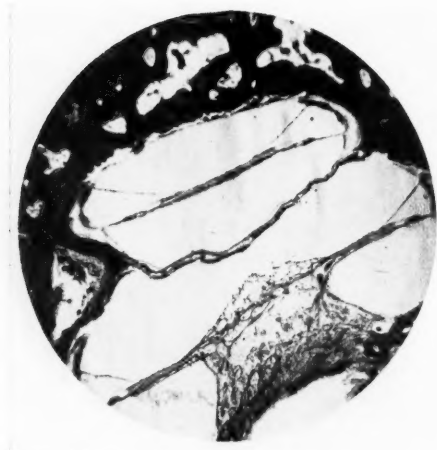


Fig. 6.—Undulatory bending of osseous spiral lamina of the upper cochlear turn.

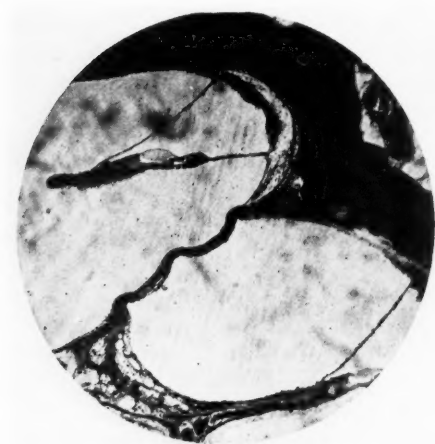


Fig. 7.—Compression of the osseous lamina between the upper and middle turns of the cochlea. The Corti's membrane is relatively well preserved.

and the antrum completely, which in turn led to adhesions between the drum membrane and the promontory wall, thus leaving the ossicles in an unchanged shape.

Also analagous were the relations between the subcutis and the underlying bone. The partly calcified dura mater above the pyramidal surface showed the same changes on either side.

SUMMARY

In a case of generalized Paget's disease with deafness, both temporal bones were involved and reconstructed except for small remains of the labyrinthine capsule.

The newly formed bone was spongy in the apex and in the mastoid process and more compact in the labyrinthine area.

The bone marrow was lymphatic, fibrous, or fibrofatty in the new constructed areas.

The desultory process of bony rebuilding originates mainly in these marrow spaces.

Bone absorptions of lesser degree took place partly in connective tissue surroundings of the nerves and vessels or in the submucosa. Small marginal appositions of the bone started in the areas of subcutaneous and subdural tissue.

The labyrinth was profusely replaced by a compact and almost marrowless bone. The invasion toward the old bone was accomplished by arcuate, humplike bony processes without any distinct osteoclasia.

Both the modioli and the maculae cribrosae were completely free from reconstruction.

The membranous labyrinth in the cochlea and vestibulum, as well as the ganglia and nerve fibers, were normal and showed only agonal and post-mortem changes.

There was a chronic adhesive process in both middle ears marked by multiple scars and cysts with a normal chain of ossicles.

In case 2, S. L., a male, aged 72 years, had had a distortion of the thoracic vertebrae since his youth. When he was 50 years of age, the patient had recovered from pneumonia.

In September, 1928, while leaning on his arm at the edge of a table, he fractured his right humerus, spontaneously, and was treated



Fig. 8.—Horizontal section of the skull showing a thickening of both temporal bones.

by a plaster cast and Christian splint for six weeks. After this there was still no union and no evidence of callous formation.

The patient was admitted to the department of surgery with the following findings: The patient was a small man with a large, round, uneven surfaced skull, completely edentulous, and having a severe kyphosis of the thoracic vertebrae together with a scaphoid anterior chest wall. There was hypertrophy of the right heart which had a presystolic murmur at the mitral valve. An extensive indirect inguinal hernia extending into the scrotum was found on the right side. Edema of both legs was present. Swelling of the surrounding tissue and a small suppurating fistula were present at the point of fracture, which was not painful.

During the four weeks that followed a large coarse tumor developed in the region of the right shoulder joint. X-ray showed an apparently spontaneous oblique fracture of the right humerus in its upper third with an excessive movement of both fragments and several round areas of lesser density at both ends of the bone.

X-ray of the skull revealed a typical Paget's disease with a thickening of the base of the skull and cloudy appearance of the entire cranium. The pelvis and the proximal ends of both femurs showed also the typical changes of Paget's disease.

The urine showed 13.4 mg. per cent of calcium. Later the patient developed a pseudoarthrosis and the increasing growth of the tumor finally led to amputation of the arm. The tumor, both in the gross and microscopic studies, showed that both fragments of the humerus were typical of Paget's disease with an excessive resorption of the bone and new formation of osteoidal tissue and nearly a complete transformation of the marrow to a fibrous type. At the proximal end there was a large spindle-cell sarcoma, which could not be established anywhere in the marrow tissue; due to its circular arrangement it was interpreted as being a periosteal sarcoma.

One year later, in October, 1929, the patient again complained of pains in the scar, where two apple-sized tumors had developed. At the same time the patient stated that he suffered for eight days with an earache and discharge from his right ear.

Both tumors were removed surgically. Microscopic study of the tumor section showed recurrent sarcoma of the spindle-cell type.

The examination of the ears revealed thin pus in the right external canal; the drum membrane was inflamed and bulging. There was also a round perforation in the lower posterior quadrant, with pulsating pus. The left external canal was dry, and the drum membrane was slightly reddened. The hearing test was as follows: whispered voice not heard at all in either ear; conversational voice not heard in right, but 5 to 10 cm. on left; C-1 and C-4 were markedly diminished; Weber lateralized to the right; Rinne was absolutely negative on the right and indefinite on left. Schwabach was foreshortened on both ears.

The caloric vestibular reaction on both ears was negative after the minimal method and a diminished response was manifested, after mass cold irrigation. The fistula symptom test was negative, but the patient reported a dizzy feeling. The patient remained two weeks longer in otologic care and was discharged while still having a running ear.

Two months later the patient was again admitted with a severe paralysis of both legs and difficulties in speech. There was a continuous suppuration from the right ear. The patient died from heart disease fifteen months after the accident had occurred and two and one-half months after the infection had begun in the middle ear.

The following can be summarized from the post-mortem findings: Above the left frontal protuberance there was a soft tumor the size of a walnut with a diffuse destruction of the bone in this



Fig. 9.—Section through the left pyramid showing the extraordinary dilatation of the jugular bulb.

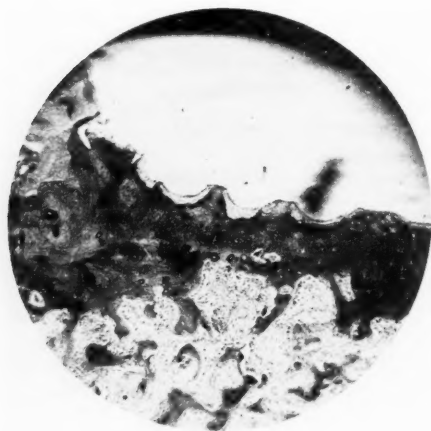


Fig. 10.—Dense bone around the vestibulum with crenation of the inner surface and recent absorptions.

area. The bony capsule, especially in the occipital region, appeared thickened to 12 mm. and was very soft and disorganized in structure. In the bregma there were several globular metastatic formations built of soft tissue and replacing the bony structures. These were about 10 mm. in size. The basal cerebral arteries were sclerotic. The brain was totally reduced in size. In the lentiform nucleus was seen a lenticular cyst due to softening of the brain tissue. In the right lamina cribrosa there was a metastatic tumor the size of a hazelnut. The bone of the anterior fossa was thickened and through it the floor of the fossa was elevated. The conditions of the posterior fossa were the same, while the middle fossa and the sella turcica appeared more thinned out. There was a metastatic tumor in the medulla spinalis at the level of the fourth thoracic vertebrae. There was kyphosis and lordosis in the lower thoracic and lumbar regions. Multiple osteoclastic metastatic tumors in the bodies of the eighth to tenth thoracic and in first and second lumbar vertebrae, as well as in the sacral bone, were also present. The bone of the right femur was reconstructed and sclerotic. The diaphysis contained red marrow spaces and the eburnized epiphyses a fatty marrow. The lungs showed white tumor masses the size of an egg and the myocardium, especially the left ventricle, and the thyroid gland were showered with small lenticular metastatic tumors. The histologic examination of all these metastatic tumors showed a fusocellular sarcoma.

The pathological diagnosis was:

1. Metastatic fusocellular sarcoma of both lungs, myocardium, and left thyroid lobe, also of the skull, ribs, vertebrae, sacrum, and right iliac bone.
2. Compression of the spinal cord.
3. Recent lobar pneumonia of both inferior lobes.
4. Old endocarditis of the aortic valves and stenosis of the orifice of the aorta.
5. Concentric hypertrophy of the left ventricle.
6. Adenoma of the prostate.
7. Paget's disease of the skull, vertebrae, and right femur.

Both pyramids were available for histologic examination and were prepared in the usual way (Fig. 4).

In looking at the slide grossly, it appeared that the angle of both pyramids was distinctly flattened and the pyramidal bone itself was entirely enlarged.

The low-power microscopic examination of the right pyramid showed that the anterior part of the pyramid was replaced by a new spongy bone and that the area around the tube was surrounded by a rarefied cellular complex and thin bony spicula, which stained fairly blue with hematoxylin-eosin. The posterior part of the pyramid showed on the other hand a spongy new bone, but of a more dense structure; it contained partly fibrous and partly fatty marrow spaces.

The bone of the entire pyramid exhibited mosaic structures representing a very vivid previous bony reconstruction still present and also areas showing new growth of the tumor at the roof, above the acoustic canal.

The high-power microscope showed that around the tubal canal and around some apical cell spaces there were individual bony beams composed of the old lamellar bone. These extended from the separating wall to the tensor muscle into the newly formed bone and appeared more blue. The new red-stained bone appeared in some places separated only by a thin blue line or a post-mortem cleft. It showed the manner of the arcuate attack of the new red bone. In the fissure itself there were no cellular elements but some very small blue-stained fragments.

In some of the old blue-stained spiculae one could distinguish the bony cells with their fine canaliculi, whereas the new reddish contact bone showed only the cells well, but the canaliculi were slightly indicated.

Finally, in the tubal region were a few bony beams with a newly formed bone in the center of it.

The peripheral border at the longitudinal side of the beam consisted only of a small lamellar seam.

The tubal lumen seemed to be filled with a purulent secretion; the mucous membrane was highly swollen with villous elevations. The submucosa was loosened and its engorged vessels were perivascularly infiltrated.

At the bony tubal canal, which sporadically still consisted of old lamellar beams, an enormous absorption had taken place, just approximal to the most acutely advanced areas of inflamed mucosa (Fig. 5).

The rebuilt bone also showed erosion by the presence of rows of giant cells, giving the impression that the old process of reconstruction would be newly reactivated by the neighboring inflammation. Where the bone was adjacent to the marrow spaces, bony apposition and absorption could be observed side by side.

The same inflammatory changes took place in the mucosa of the peritubal and pericarotid cells. The mucous membrane appeared incomplete here and there, showing destruction of the cell linings and lumina which were filled with pus and debris.

The bony layer adjacent to the adventitia of the carotid was of lamellar structure in some places. Between the individual lamella there was enclosed the newly built bone. It can be assumed that this new bone was derived from the perivascular tissue of the bony vessels, or that the section did not reach the center of the marrow space, because the cut could have been made through the periphery of the bony process.

Very small rosy seams underneath the submucosa could be established at the remnants of the old bone and at the new rebuilt beams, which encircled a cellular lumen. These osteoidal seams filled up either a shallow lacunar space or the apposition had taken place at a boundary line, whereby the osteoblastic cells appeared more flattened compared with the osteoblasts derived from the fibrous marrow.

In the more medially situated sections was present the carotid bony canal, composed of the newly rebuilt bone. Toward the lumen of the vessel there was a scanty bony apposition, but no absorption.

This moderate occurrence of apposition took place in the areas of adventitial vessels, which probably supplied the tissue with osteoblastic elements.

The wall of the carotid appeared much thicker in the apical region; the partly absorbed layer of the media was replaced by large calcific deposits.

The bony frame around the tensor muscle consisted of new bone throughout. At the tubal side the bony form showed a vivid reconstruction, while other parts of it were replaced by fibrous tissue. Muscle fibers were rare and were displaced by bundles of connective tissue.

In the sections of the middle ear the bony wall was completely reconstructed. The drum membrane, framed in the new bone,

showed the typical picture of a subacute inflammation. There was a thickening and cellular infiltration of all three layers of the membrane. The mucous membrane of the middle ear was edematous and in places the epithelium was missing. The submucous tissue was infiltrated with serum and cells while in its deeper layers it blended with the fibrous marrow spaces. The communications could be particularly well observed in the area of the rebuilt promontory wall, where both fenestrae were filled with pus. The cartilaginous covering of the rebuilt vestibular window appeared thin in the posterior and upper portions. The secondary tympanic membrane was more loosened and was still adherent to parts of the old labyrinthine capsule. The ossicular chain showed on the mucosal surface corresponding inflammatory changes. The cartilaginous linings and the bony masses appeared normal. In the lumina of the few small perilyabyrinthine cells and in the larger cell spaces of the tegmen, mucosal losses, fibrinous cellular exudations, and pus could be established everywhere.

The loosened submucous texture showed a great many engorged vessels and the tissue meshes appeared filled with inflammatory cells. Here and there were communications with the pathologic marrow.

At the surface of the rebuilt bony trabeculae there were bony appositions in the direction of the lumen, which were produced by elements of the submucosa, usually seen in cases of mastoiditis. Rare bony absorption or lacunar erosions could be observed.

In contrast to the above findings there were at the surfaces of the bony trabeculae new violent reconstructions, more frequently near an active inflammatory focus. These were only rarely further away from the more active foci. All the above findings were seen adjacent to the pathologic marrow spaces. The degree of inflammation seemed to spur the pathologic fibrous marrow on to a tendency to activate the already resting process.

The course of the otitis was alike in the antrum and in the neighboring tegmental cells.

In two places the tegmen plate appeared completely destroyed and the lumina of the cells were covered with the thickened and highly vascularized dura mater. Consequently, a subdural abscess was established at this part of the middle fossa.

Moreover, the dura mater was connected with the fibrous marrow in several places whereby the separating bony lamellae disappeared by absorption from the fibrous marrow tissue.

The mucous membrane of the scanty tip cells appeared somewhat thickened but was without any signs of the inflammation which predominated in the upper part of the mastoid.

At the posterior surface of the pyramid was a distinct narrowing of the acoustic canal. There was a thickening of the roof and the wall, consisting of an older rebuilt bone with very dense and tightly formed mosaics. There were scanty fatty marrow spaces and occasionally mild reconstructions. At the medial and inferior diameter of the acoustic canal, and also in the interior of the rebuilt bone, was a very rich vascularized sarcomatous tumor, infiltrating the marrow spaces, spreading in an area for about 4 mm. in depth and width and destroying the bone around it.

The sarcomatous growth was chiefly composed of spindle-shaped cells with an elongated nucleus and scanty cytoplasm. Near the bony wall, the tumor cells appeared rounder. There was a greater concentration of cells near the capillary vessels, which were surrounded by swollen endothelial cells. The enlarged lumina of the capillaries were lined by tumor cells.

Where the tumor touched the bone the individual tumor cells were somewhat larger, were polyhedral in form, and resembled giant cells in that they possessed large vesicular nuclei. The intercellular stroma was very scanty and in the center of the tumor was not visible. The lacunar erosion of the bone could be found in various degrees, giving the bone a crenated appearance.

Where the tumor lay adjacent to the bone, there was a large blue line or the bone itself was discolored. The rebuilt bone appeared more rosy, probably due to decalcification. Between the two tissues lay fragments of destroyed cells. Toward the fibrous marrow spaces the spindle cells were more loosely packed and less vascularized. They were swollen and oval shaped. They infiltrated the vascular lumina, which also reached the fatty marrow spaces.

The process of bony destruction was sporadically rapid to such an extent that only notched bony remains were found in the stroma of the tumor. No new bone formation was seen near the tumor cells.

Although the bony destruction reached the acoustic canal the lumen of the canal itself was free from tumor cells. The perineural sheaths appeared swollen, the fibers were disproportionately thick and fragmentary, and the septa of the glia carried through numerous psammoma.

The fallopian canal showed in its middle ear course at the level of the stapes head, laterally, a small convex spangle of the old blue-stained bone. This bony arch did not appear smooth, being pressed from all sides by the new bone and assuming a wavelike form.

The facial nerve appeared deformed like the surrounding canal; in its posterior aspect it was rectangular instead of round and was partly encircled by a hyalinized connective tissue. There were no visible changes in the structure of the nerve fibers themselves.

In the beginning of the descending facial nerve just near the utriculoampullar region, a small sarcomatous tumor plug reached the sheath of the seventh nerve. Together with two other projections it came up to the macula of the utriculoampullar nerve and in some deeper areas it came up to the riddled bone of the utricular nerve. Here the scanty tumor masses filled the small marrow spaces without any marked bony destruction.

The bony area of the labyrinth in both its portions was equally replaced by the new rebuilt bone, which itself appeared traversed by numerous fissures of various sizes.

Small remains of the old capsular bone were preserved only in the area between the basal and middle turn of the cochlea. The basal nervine canaliculi of the cochlea appeared narrowed by an abundant production of reticular bony substance. Here the nerve fibers were reduced in number and carried many pigmental deposits.

The ingrowth of the new bone into the base of the modiolus occurred in the same way as in the endosteal layers of the labyrinthine capsule. There was a humplike invagination of the new bone toward the lumen of the cochlea but nowhere were there elements of osteoclasia present.

At the contact of the two bony types the new bone appeared separated by a tiny blue limiting membrane which appeared in a section as a small blue line. In places where the old labyrinthine capsule was completely replaced by the new bone the inner surface of the labyrinthine canal did not appear smooth, but had projections of small bony absorptions, while the lumen was uneven and crenated in various areas.

The modiolus and to a lesser degree the endosteal layer of the labyrinthine capsule seemed to offer a great resistance to the new invading bone. While both the external layers, the periosteal and enchondreal, were nearly completely rebuilt, the inner endosteal layer became at first often displaced by the pressure of the ingrow-

ing bone and sporadically showed only traces of the old lining. In more advanced places the inner layer disappeared completely and the labyrinthine lumen stayed in direct contact with the new bone, consisting of a flat row of absorption spaces filled with a loose fibrous marrow or homogenous osteoidal rosy tissue and lined against the lumen either by a very small blue line or by a thickened endosteal cell layer.

In the lumen itself slight accumulation of a cell-free transudate could be found, probably an expression of the surrounding decalcifying process.

The osseous spiral lamina of the modiolus were indented in the longitudinal sections, so that the flat level plates appeared bent and undulatory. Those cracks in the lamina were particularly well pronounced in the middle turns of the cochlea, where the new bone reached the labyrinthine lumen early. There were also multiple fractures in the tiny lamellae and callus-like repairs can often be seen (Fig. 6).

The cochlear channels appeared, therefore, unusually deformed and even the vascular stria, losing its semicircular attachment, surrounded a rectangular canal in the area of the scala tympani.

In the extremely deformed septal canals the nerve fibers were either completely missing or they were reduced in number, atrophic, and loaded with brown pigments.

The same changes were found in the corresponding middle ganglion of the modiolus.

In spite of the destruction of the bony cochlear frame, and in spite of the above-mentioned deformities of the lumen, the Corti's basillar membrane showed relatively little change. The hair cells and the supporting cells were relatively well preserved as were also the tectorial membrane and Reissner's membrane.

The new bone around the vestibular part of the labyrinth was more compact and consisted partly of lamellar structures arranged very close together and intruding into the inner endosteal layer. The reconstruction of the remaining old bone occurred in the same way as in the cochlea. At the places where the newly replaced bone reached the lumen of the semicircular canal, the inner surface had become crenated and the lumen deformed.

The membranous labyrinth was scarcely changed; only in the perilymphatic spaces near the bony absorptions and in the utricular cisterne were loose clots without any cellular elements.

At the maculae cribrosae the process of the bony replacement resembled that of the modiolus. Small traces of fibrous marrow tissue sporadically invaded the nerve canals.

The endolymphatic duct, surrounded completely by the newly rebuilt bone, was normally situated and its separating connective tissue carried numerous calcified deposits. The dura matter appeared thickened, particularly at the anterior pyramidal wall. The subdural tissue was at several places connected with open fibrous marrow spaces, but the border was generally well defined against the rebuilt bone and was lined by a thin blue line. The projections of the subdura produced here and there, in contact with the new bone, new appositions. In the area of the superior petrosal sinus, the wall was more homogenous, of hyaline appearance, and with large calcium deposits, which were irregularly distributed in the dura everywhere.

In the left pyramid the angle built by both upper pyramidal surfaces was rounded off. The bone of the entire pyramid, as well as that of well pneumatized mastoid, showed reconstruction sponge-like in the pyramid itself, but more firm around the labyrinth.

The cells in the tegmental area and around the antrum were made up of thin newly built walls, covered with some thick mucosa and lined with a flat epithelium everywhere. The small narrow spaces contained throughout a fibrous marrow with only few manifest reconstructions. In the tip cells of the mastoid and in the cells of the retrofacial area, the lumina appeared more tapered and filled with a scanty rosy exudate, which contained individual lymphoid cells, in some places. The mucous membrane was somewhat thicker in these cells and the vessels were engorged in the submucosal layer.

The marrow spaces around the sigmoid sinus were filled with sarcomatous tumor masses, which melted down the surrounding rebuilt bone by means of giant cells and huge spindle cells. At the lower and medial limits, the tumor reached the wall of the sinus and the vascular sheath appeared rigid with fine calcific deposits and the lumen of the sinus was narrowed by a small thrombus formation of marantic character. This sarcomatous plug connected with another metastasis was situated in the bony frame of the acoustic canal, similar to that of the right side, and separated from the lumen of the canal only by a very thin bony wall.

Another sarcomatous process projected itself into the vestibular part of the labyrinth where the reconstructed bone already contained fatty marrow spaces. Extending into an area of 5 mm. it

destroyed the surrounding bone, leaving only a few small irregular shaped bony fragments.

In some places, at the border of the tumor and the reconstructed bone areas, was very hastily built new bone. These bony areas carried a multiplicity of short parallel cemental lines, which seemed to be incompletely calcified. Since no new bone built by the tumor was found it seemed difficult to determine whether this bone was built by the cells of the sarcoma or whether it was the first step toward a decomposition of the already existing reconstructed bone with a simultaneous loss of calcium.

The bony changes around the eustachian tube and the carotid canal were identical to those in the right pyramid. At the bottom of the tube and in the few peritubal cells was a swollen mucous membrane, covered with pus and a slight hemorrhagic exudate.

The wall of the carotid, in its media, was impregnated with several calcific deposits and surrounded by a remnant of the old bone only adjacent to the cochlea. The rest of the bony channel consisted of a new bone with only few new reconstructions of the fibrous marrow spaces.

There was but very little pus in the middle ear space, but both fenestral niches and the hypotympanum were filled with purulent exudate at various places, in the well-vascularized, thickened mucosa there was a cellular infiltration, while in the underlying rebuilt bone a rich reconstruction activity had taken place from the fibrous marrow spaces. Here it is important that the osteoidal appositions were larger than those built by submucosal or perivascular tissue. The bony frame of the tympanal membrane as well as the bony external canal consisted of a previously rebuilt bone. The drum membrane itself was thickened and bulging in its lower portion. In the region of the long process of the malleous there was a 3 mm. by 3 mm. cyst with a thickened, partly calcified external wall and a flat epithelial lining. The lumen of the cyst was filled with rosy stained homogenous fluid which did not show any cellular components.

The ossicular chain appeared to be of normal structure. The rebuilt promontory wall included both fenestrae, and a greater fibrous marrow space in its lower segment which corresponded to the marrow spaces of the hypotympanum, which contained several purulent cell spaces.

The cartilaginous notch in front of the oval window was also partly substituted by the new bone and in the otherwise normal look-

ing annular oval ligament there were small calcific deposits in the anterior and lower segments of it.

In the tegmental reconstructed plate of the middle ear were cells filled with pus. Both muscular channels and the bony canal around the facial nerve were surrounded by the newly rebuilt bone only in the middle ear region while near the stapes the bony facial canal still consisted of the old lamellar bone forming a half ring. This bony segment seemed also to resist the invasion of the new bone for a long time and as an expression of this state, this half of the facial canal appeared as a wavy plate.

The bony area around the acoustic nerve, as well as the entire labyrinthine capsule, was, with a few exceptions, replaced by the new bone. Of all three layers the inner layer only was preserved in sections. Occasionally structureless cartilaginous remnants appeared in the new bone. The modiolus, which seemed to be preserved, was again an exception, showing the same relation to the new bone as that in the right labyrinth.

The bone of the acoustic canal, partly replaced by the sarcomatous tumor, as was mentioned above, showed a rich reconstruction activity. In the lumen of the canal fresh hemorrhages appeared. In the narrowed nerve canals of the fundus, the nerve fibers appeared to be shrunken, while the glial septa had large calcific deposits and psammoma grains.

In the spiral ganglion there was a distinct shrinkage of ganglion cells.

The vivid reconstruction in the area of the basal cochlear turn, especially in the medially situated parts of the bone near the carotid canal, produced a sort of deformed elongation of the cochlear basal lumen. The receding limbus caused the normally arcuate transversed section in this area to appear rectangular.

The canal of the endolymphatic duct was somewhat narrowed in its normal course in relation to the posterior fossa and its lumen appeared partly filled with calcified concretions.

In spite of the tremendous reconstruction of the bony labyrinth the soft labyrinthine parts appeared only slightly affected. In the places in which the individual bony septa of the modiolus, compressed by the new succeeding bone, had become bent in their longitudinal axis, the nerve fibers had undergone changes, which were due to the distention. The epithelial linings of the basillar membrane had remained in relatively good form (Fig. 7).

In the area of the upper semicircular canal the bone adjacent to the superior petrosal sinus was defective and had been replaced by a connective tissue wall. The adjoining peri- and endolymphatic spaces were filled with loose cellular fibrinous-like masses which reach partly the upper and partly the posterior utricular recesses. The wall of the petrosal sinus itself was partly calcified and showed a beginning ossification in its posterior portion. In the lumen of the sinus a small nonobturating thrombus could be seen.

The vestibular portion of the labyrinth appeared almost completely reconstructed. The inner bony surface of the vestibulum and that of the semicircular canals were no longer smooth. The flat resorptions reaching the thickened endothelial linings and separated by various pointed bony ends gave a crenated appearance to the surface.

The dura mater of the posterior fossa was thickened here and there. The fibrous marrow of the new bone in some places had broken through the external bony lamella and in this manner penetrated from the outside into the periosteal layer, thus causing an extreme thickening of the dural membrane. Close to a recent rebuilding focus, there were calcifications in the dura. At the pyramidal margin the usual separating blue cemental line was absent, there being instead of it a small osteoidal seam with a beginning ossification contacting the dura mater.

SUMMARY

A case is reported in which a patient, suffering from a generalized Paget's disease, had a spontaneous fracture of the humerus, followed by sarcomatous degeneration and multiple metastases. A middle ear suppuration complicated the disease in the last two and one-half months of the patient's life.

The histologic examination of the temporal bones revealed a generalized reconstruction of both pyramids with a flattening of the pyramidal angle and an increase of the entire bony volume.

The new replacing bone appeared partly spongy, partly dense with a fibrous, fatty or mixed marrow tissue. Around the labyrinthine lumina, however, there were few narrowed marrow spaces.

There was evidence of a bilateral subsiding otitis with an enormous absorption of the resting bone near the inflamed areas of the mucous membrane. A new bone formation also took place in the

perivascular channels and from the submucosal tissue. Symmetrical sarcomatous metastases were found in both pyramids.

The newly replaced bone attacked the labyrinth in an arcuate formation. The endosteal layer and the modiolus showed a violent resistance against the replacement which resulted in crenation of the inner labyrinthine surface and deformation of the spiral osseal laminae followed by degeneration of the nerve fibers.

The resistance of the external bony lamella of the facial canal against the new reconstructing bone exhibited a wavelike formation in the middle ear area.

There was relatively good preservation of the membranous labyrinthine parts.

The ossicular chains appeared to be free from any reconstructions. A periosteal thickening of the bone could be shown in the area of the dura mater and in some subcutaneous regions.

There was a large calcification of the carotid middle layer and a sporadic calcification and ossification of the sinuses and dura mater.

The temporal bones of Case 3 were given to me by the coroner of the Medicolegal Institute of Vienna. These temporal bones were from a 70-year-old male who died in a streetcar accident and whose previous history was not well known. The relatives stated that the deceased was completely deaf and that his skull had been greatly enlarged for several years.

The post-mortem examination revealed multiple bone fractures in a Paget diseased skeleton, a highly degenerated heart muscle, and ruptures of the parenchymatous organs.

Macroscopically there was seen a thickening of the skull, especially of the right side. The squamous portion of the temporal bone attained a thickness of 22 mm. Both fossae of the skull were flattened and the pyramidal margins were rounded. The thickening reached the frontal, sphenoid, and ethmoid bones. The very soft bone could be easily cut with a knife (Fig. 8).

The X-ray of the base of the skull, made before the laboratory decalcified the bones, showed a marked structural rebuilding of the bone, as indicated by thickening of the spongiosa outlines and striated arrangements. These occurred very distinctly in the anterior parts of both pyramids. The labyrinthine capsule was easily recognized and was thinner than normal. The longitudinal axes of the pyramids had assumed a slightly convex curvature.

Both temporal bones were cut in vertical serial sections, stained with hematoxylin-eosin or Giemsa, and some of the sections were examined unstained in polarized light.

Both pyramids showed almost identical pathologic changes. In comparison with the changes formerly described, the temporal bones showed in this case a very progressive stage of the disease.

Even macroscopically there appeared a rounding off of the pyramidal margins and an extreme dilatation of the jugular bulb can be noticed (Fig. 9).

The jugular vein reached the middle ear and spread posteriorly under the labyrinth and the inner acoustic canal.

The pyramids were of spongy character throughout and appeared more dense only in the labyrinthine areas, in which they took easily the dark blue stain of hematoxylin. The spongy bone consisted mainly of very thin rosy spicula, which partly coalesced and partly were singular and which lay enclosed in the loose fibrous marrow tissue. The very small bony beams already had been rebuilt, carrying innumerable short blue cemental lines and becoming again reconstructed by the loose and very well vascularized fibrous marrow tissue. The process of resorption of this newly formed immature bone was seen in the large Howship's lacunae filled with giant cells in which fifty or more nuclei could be counted. The apposition of the new bone was formed by large round marrow cells which in the center of the marrow space appeared more lengthened. These osteoblasts forming superficial rows had built comparatively large osteoidal seams and had become sporadically enclosed in the areas of the newly formed bone. In the very small fissures between the bone surface and the giant cells, cellular fragments and singular deformed cell nuclei could be found.

In the very midst of this rarefied bony tissue, rich in marrow, the labyrinthine nucleus appeared on all sides absorbed and newly rebuilt. Small remnants of the old middle and inner layers could be seen at the base of the cochlea, between the singular turns, at the floor of the vestibulum and in places near the sections of the semi-circular canals. In the remaining areas, the newly formed bone reached the labyrinthine lumina in all directions.

The new replacing bone of the labyrinth appeared dense, partly lamellar around small vessels, which themselves had a broader sheath of perivascular connective tissue. The attack of the new rosy stained bone, against the more pastel blue colored labyrinthine remainders,

had taken place in the humplike manner described above. At the junction of the two types of bone a very small slit appeared here and there, but generally a small cemented line separated one from the other. In these small slits, probably of post-mortem origin, there were fragments of bony cells of the old capsule. At the site of pathologic action, the structure of the old labyrinthine bone appeared more hazy; the bone corpuscles were shrunk or completely gone and the osteocytic spaces were empty. The attacking rosy bone often showed larger, rounded bony corpuscles with distant nuclei and abundant processes. Singular, isolated cartilaginous cells of the middle labyrinthine layer or groups of them were enclosed in the new reticular bone, which also had become pastel blue stained and was separated from the older pathologic bone by a fine blue limiting membrane. This process of bone replacement stopped at the modiolus, but the spiral laminae had become also bent, especially in the top turns, causing marked deformations of the cochlear lumina.

This rather mechanical deformation of the spiral bone laminae, arising apparently from the tissue pressure of the reconstructed surrounding bone, had produced changes along the nervine and vascular contents in the canals, which consequently had led to degeneration and lifting of the epithelial linings in the membranous parts of the labyrinth.

The reconstructing process also had penetrated the area of the vestibular apparatus. The newly built bone around the vestibulum consisted of a more compact layer, while the entire temporal bone showed a general porosity of the bone structures. The very dense bony formations around the labyrinth were obviously due to the fact that vascularization and a lack of marrow tissue in these areas were normally poor. The small vessels of the osteocytic corpuscles of the overlying mosaic bone were larger and contained rounded nuclei.

The bony canal of the carotid and the eustachian tube showed mosaic structures with abundant marrow spaces all around. The lumen of the tube was normally wide, although the fibrous marrow tissue had penetrated forward into the epithelial linings, destroying the tunica propria, but leaving the overlying epithelium untouched. In the small peritubal and perilabyrinthine cell spaces the epithelial linings appeared normal. The submucous tissue was somewhat thicker and less vascularized, while at the rebuilt bony beams small osteoidal appositions, derived from the submucous tissue, appeared sporadically. In some places the fibrous marrow reached the epithelium of a cell space, without changing its structure.

The same pathologic changes occurred around the tensor tympani and the short course of the stapedial muscle, the fibrous marrow often being pushed forward to the perimysium and the muscle fibers becoming partly replaced by fat or connective tissue. Also seen were small osteoidal appositions built by the perimysial tissue at the walls of the channels.

Recurrent small osteoidal appositions also appeared in the course of the facial nerve canal where dense bone were always surrounded by larger dark blue mantles and due to their arrangements, they belonged to the old labyrinthine capsule (Fig. 10).

In the places where the new bone reached the lumina of the vestibulum or the semicircular canal, it formed flat absorption spaces which appeared to be separated by small bony spicula, forming sharp points. At the junction of these crenated areas and the perilabyrinthine spaces, very loose flakes appeared here and there. The vast reconstructions of the labyrinthine nucleus had caused only very small deformities in the vestibular areas and the membranous parts as well as in the endolymphatic spaces and were in a relatively good condition.

The inner acoustic canal consisted entirely of the newly rebuilt bone and it seemed that this part of the pyramid was more susceptible to the disease and therefore, was attacked early. The thickening of the upper wall of the canal caused a marked narrowing of the lumen. The fibrous marrow broke at several points into the perineural tissue, but on the other hand the perineurium itself showed large appositions at the rebuilt mosaic structures, forming a parallel structured bone with straight, narrow cemental lines. The osteoblastic cells which had become enclosed in the newly formed parallel bone appeared small, elongated, and spindle-shaped, whereas the walls were made up of the new reconstructed bone. The only old bony spangle, as seen in the previous sections, were preserved in the typical section of the middle ear, just medial to and above the stapes head.

The bony walls of the normally wide tympanic cavity consisted almost entirely of the pathologic rebuilt bone. The only exception, showing the old bony remnants, could be found in the promontory wall, where an active reconstructing process had originated in the fibrous marrow spaces and where deep submucosal indentations had broken into the bony mosaics. The niche of the oval window appeared to be rebuilt up to a very small lamella beyond the facial nerve canal. On the opposite side toward the posterior stapedial crus, a small round cyst, filled with hyaline masses, could be seen. Another small remainder still existed at the anterior and upper parts of the

round window, reaching partly the attachment of the cochlear membrane. The annular ligament as well as the ossicular chain appeared free from any reconstructions. The triangular attachment of the normal drum membrane was separated by a blue line from the rebuilt bony frame, as was the subcutis which was bordered by a blue mantle. Toward the rebuilt surroundings of the external bony canal, the hypotympanic bony partition was partly destroyed and was replaced by a thin connective tissue membrane, built by the bulb of the internal jugular vein.

The epithelial linings of the middle ear showed normal structures with the exception of the above-mentioned submucosal indentation at the promontory wall.

The mastoid process was composed of moderate-sized pneumatic air cells and its bony walls consisted completely of mosaic structures, which occasionally contained scanty fibrous or fatty marrow spaces. The epithelial linings of the mucous membrane appeared normal and here and there its submucosal connective tissue was in relation to the fibrous marrow spaces. In several places the cellular bony wall was destroyed and the mucous membrane contacted the membrane of a neighboring cell but generally a small blue cemental line separated the mucosal membrane from the underlying bone. Medially, in the apex area and in the adjacent sphenoid, the new bone was spongy in character, was better vascularized, and showed more active reconstruction.

The bulb of the jugular vein appeared much enlarged; it embraced the middle ear and the labyrinth from below, and extended posteriorly to the pyramidal surface reaching laterally to the descending fallopian canal.

This enlarged vessel is surrounded by a very rarefied bone, whose well-vascularized fibrous marrow spaces were overfilled with giant cells, which reached the vein in many places. The relatively little pressure in the vessel was probably sufficient to bring the soft and inferior bone to this degree of absorption.

Besides the extraordinary thickening of the temporal bone, which had grown by enlarging the fibrous marrow cavities and by moving apart the very thin bone spicula, there were periosteal bony appositions at the junctions of the bone with connective tissue near the jugular bulb. This process of apposition appeared very distinctly in the squamotympanic fissure. At a small bony bar with an unusual endosteal thickening a periosteal growing process was well marked by small rosy seams, produced by connective tissue cells. The same

process of apposition repeated itself under the subcutis of the external acoustic canal and under the periosteum of the mastoid process, where the appositional cells were derived from the deeper cambium layer. At other places transitions of the fibrous marrow into the subcutaneous tissue could be noticed. The connective tissue fibers had become thicker, had hyalinized, and had merged with the unraveled bony lamella, but otherwise the subcutis appeared separated by a thin blue cemental line, which was closely adherent to the elongated subcutaneous cells and fibers.

SUMMARY

A third case of a generalized Paget's disease is reported. It presents a very progressive stage of the pathologic changes in both temporal bones, reaching all three layers of the labyrinthine capsule. The former spongy substance was replaced by a new mosaic bone with enlarged marrow cavities and changed bony bars were moved apart. The marrow cavities were mostly filled with a loose, well-vascularized fibrous tissue, containing large giant cells. The labyrinthine capsule consisted of dense compact lamellar mosaic structures, built around the old labyrinthine vessels. The new bone substitute had grown in a humplike manner and reached the labyrinthine lumina with uneven surfaces. At the modiolus and the facial prominence in the middle ear cavity, the replacing process stopped, causing characteristic deformations.

Besides the usual endosteal thickening a periosteal growing of the bone had taken place. The air spaces in the pneumatic mastoids and middle ear cavities were of normal width and of normal structure, as were also the middle ear ossicles. The extraordinary large jugular bulb embraced the pyramids in all directions.

COMMENT

It has been repeatedly pointed out that the most important changes in Paget's disease are first originated in the marrow cavities. Erdheim was able to describe an increasing number of marrow cells, some lymphocytic-like infiltrations and small hemorrhages at the border of a Paget's focus in the skull without any changes in the bone itself.

In all of our cases the bony changes began in areas best supplied with marrow tissue, as in the tubal region, in the tegmental and hypotympanal plates, and in the spongy bone of the pyramid and mastoid. The labyrinthine nucleus, due to its almost marrowless

structures, is least susceptible to attack. The periosteal layer, being best vascularized and provided with small marrow spaces, shows in all the cases a complete reconstruction. The middle enchondral layer, with its small and scanty vessels and its cartilaginous enclosures, resists, for a time, the rebuilding power. The replacement of this middle layer becomes effective because of an invasion of the new bone from the outside. The greatest resistance is shown by the endosteal layer, the modiolus, the maculae cribrosae and the outer frame of the fallopian canal in its middle ear course. These bony parts are, as it is well known, built by ossification of connective tissue and their resistance against the replacement, or reconstruction seems to a great extent, to be dependent upon the vascular supply. The perforating vessels of the labyrinthine layers and their perivascular sheaths are the earliest carriers of bony rebuilding. In the inner layers the disease becomes in the true sense of the word, a deformity. The deformations are at first microscopic and as the disease progresses and the most resistant parts become bent, the deformations of the labyrinth can be seen in some sections with the naked eye.

Although it is not easy to demonstrate the process of reconstruction in the labyrinthine areas, one can find at the arcuate contacts of both the newly rebuilt bone and the old bone, small fissures with a few indefinite tissue remnants. The osteocytes of the new advancing bone appear more succulent, irregularly formed, almost without processes, and are gathered near the old bone. The arcuate limiting membrane surrounding the newly built reticular focus indicates the lacunary resorptions. Finally the newly substituted bone of the labyrinth becomes lamellar and of a very dense character.

The functional findings regarding the hearing seem to be well proved in the pathologic changes of the labyrinth. Setting aside the pathology found in our cases, the enchondral layer appears to be walled up by the new bone and this process may be responsible for the impairment which in the beginning of the disease carries the distinguishing mark of conductive deafness. This process of walling off could probably be compared as being analogous to otosclerosis, where in spite of a moveable stapes plate the impairment is progressive. Siebemann, in reporting a case of otosclerosis, was convinced that an extensive spongification of the bony capsule may induce a considerable diminution of bone conduction. The progressive inner ear deafness in the later stages of the disease could be due to the various deformations of the nervine canals, stretching of the nerve

fibers and consecutive atrophy and degeneration of the basillar membrane.

The vestibular functions remain for a long time intact and only in the later stages of the progressive disease do the caloric tests show diminished values. These are probably due to the fact that there is a changed bony conduction which in turn delays the reaction to coldness and heat. A complete vestibular disfunction was not noticed, even though the deafness was total. The relatively little histologic change in the vestibulum conforms to these functional findings.

The loose fibrinous accumulations seen in the lumen of the canals near the most active bony changes may suggest some chemical processes in the perilyabyrinthine fluid, probably produced in agony. The complete absence of any cellular admixtures speaks against any inflammatory occurrence.

The fact that the pathologic bone ceases to grow in the air-filled cavities of the mastoid and the middle ear and in the canals of the labyrinth still remains difficult to explain.

The air and fluid filled lumina may probably miss the important potential factor of the fermentative stimulant, which may be present in the old bone or its vascular and marrow components respectively.

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XVIII

TUBERCULOUS OTITIS MEDIA: A COMPLICATION OF THORACOPLASTY*

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Tuberculous otitis media is an insidious condition which will pass unrecognized until late, with marked deafness, unless it is looked for. Spencer² states that "tuberculosis of the middle ear is more frequent than is generally supposed, because it is easily overlooked even in patients suffering from pulmonary tuberculosis." Thoracoplasty has been accepted as essential in the adequate treatment of active tuberculosis. The incidence of tuberculous otitis media has definitely increased and has followed thoracoplasty in a sufficient number of instances to warrant investigation. This has been done in an active tuberculosis sanatorium of 350 beds. The definite increase of tuberculous otitis media found since 1938 may be due to closer observation.

Tuberculous otitis media will not be found unless all the patients with tinnitus or a feeling of fullness in the ear have a very careful examination. When first seen, the appearance of the membrana tympani is not pathognomonic of tuberculosis, but resembles that of an acute catarrhal otitis media, and only by observing the membrana tympani at weekly intervals during its evolution can the tuberculous ear be diagnosed clinically. Two patients, one in 1938 and one in 1939, were observed weekly for approximately six months and never had obvious aural discharge. A smear revealing the presence of tubercle bacilli was made from the middle ear, through the perforation in one, fourteen weeks after a clinical diagnosis had been made. This patient developed, with a dry ear, a hearing loss of 30 per cent from 128-2048 D.V. inclusive, and the other patient, with a typical clinical picture of tuberculous otitis media, had no discharge but developed a hearing loss of 40 per cent.

*Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society.

The material for this paper was taken from cases at the Essex County Sanatorium and written in collaboration with the Mosher Laboratory of the Massachusetts Eye and Ear Infirmary.

It has been found that the percentage of tuberculous otitis media as a complication of thoracoplasty has increased. During four years, 1934 to 1937 inclusively, there were five cases diagnosed by positive smear, or 0.55 per cent a year, while in 1938 and 1939, without change in the technic of operation, the percentage became 4.12 per cent per year. In other words, during the four years 1934 to 1937 inclusively, there was found one case of tuberculous otitis media in each 200 operations, while during the two years 1938 and 1939 there were four cases in every 100 operations. The clinical picture of otitis media due to tuberculosis is characteristic and the presence of acid-fast bacilli in the discharge makes the diagnosis complete. The objective symptoms have been described many times:^{1,2} In the first stage there is congestion of the membrana tympani, more marked in the membrana flaccida, which cannot be differentiated from an acute catarrhal otitis media. This stage is of comparatively short duration, and within a week the characteristic picture of the second stage is seen, a bulging drum, grayish white in color, with individual dilated blood vessels crossing the bulging portion, from periphery toward the umbo, and along the process of the malleus. The short process is prominent and the contour is that of an inflated ear. The ear may remain in this stage for a variable length of time, from two weeks to several months. The third is a moist stage with watery discharge and desquamation of the epithelium, which Blegvad¹ has described as "slush".

This "slush" may become dry and may be removed later as desquamated epithelial cast of the membrana tensa, or the moderate chronic purulent discharge, which is characteristic of tuberculous otitis media, may begin during this stage. Once the stage of chronic purulent discharge is reached in tuberculous otitis media, it is more difficult to make a diagnosis. A smear is more likely to be positive and show tubercle bacilli when the discharge is scanty and there is little or no secondary infection. Multiple perforations are not characteristic of tuberculous otitis media in this group, nor is the position of the single perforation characteristic; some were anterior, some posterior, and, in a few cases, there was almost complete destruction of the membrana tensa. Two cases had only a remnant of drum membrane extending from the umbo down to the annulus tympanicus, making multiple perforations. There is, however, one constant feature, considerable destruction of the membrana tensa, and, with healing, a marked deformity of the remaining drum membrane, thus giving one the impression of an old chronic otitis media of years' duration. The X-ray is of value in the differential diagnosis of tuberculous otitis media seen late and a nontuberculous chronic otitis

media. X-rays were taken of the mastoids in all of the patients studied. All of those without clinical mastoiditis and cell destruction by X-ray revealed pneumatization with periantral sclerosis, in contrast to nonpneumatization and sclerosis, the usual findings in chronic otitis media.

The one constant subjective symptom was a sense of fullness in the ear associated with mild tinnitus. Only three patients had pain, all after the diagnosis had been made. One of these had a tuberculous polyp, organisms being found in microscopic sections of the polyp; the other two had mastoiditis with pain. There were six patients with tuberculous otitis media upon whom no thoracoplasty had been performed. Five of these were first noted when a moderate purulent discharge from the ear was observed and positive smears were obtained. These were all far-advanced cases and very sick; four have since died.

The sixth case showed a solitary tubercle on the mucosa of the membrana tympani in the upper posterior quadrant. The only symptom this patient ever had was a sense of fullness in the ear, which was observed twice weekly over a period of two months. When she was first observed, there was a small injected area which two weeks later developed a white center. This disappeared, resulting in a minute perforation in the membrana tympani. Two months later the inflammatory reaction subsided, leaving a punched-out perforation which is still present. The patient, an arrested case, is now working at the sanatorium. She has no loss of hearing. This is an unusual case of tuberculous otitis media involving only a localized portion of the mucosa of the middle ear.

It is very difficult to prove by what means the tubercle bacillus establishes itself within the middle ear. Spencer,² Kerrison,³ and Ormerad⁴ believe that tuberculous infection of the middle ear develops by way of the eustachian tube. Blegvad¹ feels that it is hematogenous as there were no lesions in nasopharynx. Hematogenous tuberculous infection is more likely to develop in the vascular bones, rather than in the temporal bone which is relatively avascular, and hematogenous infection of the temporal bone is probably rare except in those cases in which there is a very heavy concentration of tubercle bacilli in the blood stream. Infection by way of the lymphatic system is unlikely. Piersol⁵ states that there are no true lymphatics in the internal ear. Spaces are observed in the connective tissue lining the bony walls of the middle ear and there is a feebly developed network in the submucosa of the membrana tympani which terminates

in the parotid nodes. None of the patients in this series had any remarkable adenitis. Most authors agree that tuberculous otitis media develops by way of the eustachian tube, but that there are cases of hematogenous infection.

The patients who had thoracoplasty were observed while the tuberculosis was developing within the middle ear. Following operation they had the signs, as previously described, of a slowly developing otitis media. There was, at no time, evidence of bare bone or sequestrum formation in the middle ear, and the resulting deafness was of the middle ear type, a conductive deafness. There has been no evidence of involvement of the internal ear in any of these cases. Assuming then that the infection developed through the eustachian tube, why does tuberculous otitis media develop following operation? Why was it bilateral in 25 per cent of the cases when the actual incidence of tuberculous otitis media following thoracoplasty was only 4.4 per cent? Why are there so few cases of otitis media following any general surgery if the operative procedures themselves or the anesthesia is a factor in causing this complication?

These patients had active tuberculosis, a debilitating disease of long duration, and were under treatment some time before their operations. According to Ostman's theory⁷ this could result in atrophy of the fat about the eustachian tube and abnormal patency. Perlman⁸ has suggested a method by which the patency of the eustachian tube could be measured in millimeters of mercury, and has examined a representative group of normal individuals to establish a minimal normal pressure which was 20 mm. of mercury with the patient erect. Of the twelve patients studied, two have died, one with tuberculosis and one with acute cardiac failure. The remaining ten have been examined to determine the patency of their eustachian tubes. This was done by connecting an ordinary mercury manometer to a glass nasal tip held firmly in one side of the patient's nose while the other side of the nose was held closed. The patient then blew until the "bulb" of inflation was heard through the diagnostic tube, the pressure being noted by elevation of the column of mercury.

All of the ten patients with tuberculous otitis media were examined and found to have abnormally patent eustachian tubes. These findings seemed definite and the next problem was whether all tuberculous patients had abnormal patency or whether those with abnormal patency were the only ones to develop tuberculous otitis media. With this in mind a study was made of ten patients who had had

thoracoplasty but had not developed tuberculous otitis media. The results showed that not one of these patients had abnormal patency of the eustachian tube.

The conclusion from these findings is that abnormal patency of the eustachian tube in patients with tuberculosis is a definite factor in the incidence and development of tuberculous otitis media. Two patients who have unilateral tuberculous otitis media and abnormal patency have required another stage of thoracoplasty. The eustachian tube to the normal ear was inflated with 1 part of boric acid and 4 parts of salicylic powder in an effort to make the eustachian tube less patent, to avoid infection, and thus to retain hearing in the good ear. These patients have had no difficulty and have not developed tuberculous otitis media in their one remaining good ear.

The determination of eustachian tube patency is simple and can be done without discomfort to the patient; however, it should not be done on patients very ill in bed, with profuse expectoration, and should always be done with the patient in the upright position. The purpose of this paper is to demonstrate an etiological factor in the development of tuberculous otitis media and a method is presented to reveal the presence or absence of this factor.

CONCLUSIONS

1. Tuberculous otitis media is a complication of pulmonary tuberculosis and has followed thoracoplasty in a number of cases.
2. Patients with abnormal eustachian tube patency are more likely to develop tuberculous otitis media following thoracoplasty than those with normal patency.
3. The determination of the patency of the eustachian tube is a simple procedure and should be done preoperatively. In the cases of abnormal patency measures should be taken to prevent the development of tuberculous otitis media.

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XVIX

SIMPLIFIED APPARATUS FOR LARYNGEAL
CINEMATOGRAPHY*†

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AND

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Colored motion pictures of the larynx provide a most notable advance in the study of the physiology and pathology of the larynx. Such studies provide a permanent record of individual cases and a chronological visual record of the progress of therapeutic measures. The stimulus provided by the work of LeJeune¹ and Pressman² has led to extensive work in this field and many types and modifications of apparatus are in use at the present time.

The equipment herein described as been designed to permit photography of the field seen through the direct laryngoscope, using laryngoscopes and photographic equipment which vary as little as possible from those generally used in routine laryngeal work and in amateur photography. Photographically the apparatus is so designed that the image which is seen through the direct laryngoscope fills the entire frame of a 16 mm. motion picture film. Thus, the laryngeal photograph fills the screen as the film is projected.

The laryngoscope is similar to the Chevalier Jackson adult laryngoscope. The laryngoscopic tube is altered to provide greater illumination as well as a connecting sleeve for an adapter attached to the lens of the camera. The tube is 20 mm. in external diameter and has a spatulous tip which permits easy elevation of the epiglottis and allows a wide field laterally. The proximal portion of the tube extends beyond the handle to permit the adapter attached to the lens of the camera to fit tightly to the laryngoscopic tube. Thus camera and laryngoscope make one solid unit for photography.

*From the Department of Laryngology, University of Illinois, College of Medicine.

†Presented at the Forty-Fifth Annual Meeting of the American Academy of Ophthalmology and Otolaryngology, Cleveland, Oct. 10, 1940.



Fig. 1.—Camera and lens equipment attached to photographic laryngoscope. A. 16 mm. magazine loading camera. Index finger of right hand operates camera. B. Reflex focuser. C. $f3.5$ two-inch lens with special focusing mount. D. Adapter sleeve fitting directly onto laryngoscope. E. Photographic laryngoscope. F. Battery box.

Illumination is provided by four coil-filament otoscope bulbs, mounted around the circumference of the distal end of the tube. Two of the lights are placed far anteriorly on the lateral aspect of the spatulous tip and two are placed somewhat more proximally on the lower part of the tube. These four lights are arranged at equal distances from each other around the circumference of the tube and illuminate the field with a circle of light of high intensity. During photography this illumination reaches 2,000 foot candles in intensity directed onto the laryngeal structures. Careful construction and selection of the lens tips of the lamps as well as accurate placement on the laryngoscopic tube limits the circle of light to the area actually visualized through the tube and eliminates unnecessary, wasted dispersion (Fig. 2). Through a battery box described below, these bulbs are burned at 2.5 volts during the exposure of the larynx and at 3.7 volts during the actual photography. By burning these bulbs at so great a percentage over their rated voltage the character of the light produced simulates that produced by photoflood bulbs, for which Kodochrome A film is corrected.

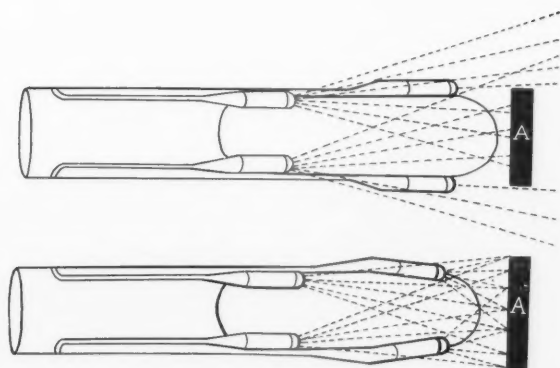


Fig. 2.—Manner of placement of lamps on laryngoscope to provide maximum concentration of light. A—Diameter of field being photographed. Top figure shows irregular dispersion of light; bottom figure, light concentrated by proper placement of specially constructed lens-tipped coil-filament lamps.

An increase in illumination has been obtained through the use of specially manufactured bulbs of the size usually used in otoscopes. These may be overilluminated with as much as 8 volts to give an extremely brilliant light, thus allowing for greater depth of focus. When burning at 6 volts their life is approximately four hours. The importance of the use of a coil filament cannot be overestimated since the single filament lamps give a greatly inferior and inadequate light.

In order to conserve the life of the bulbs, a special battery box is used which permits presetting of the voltage to be used. This battery box provides a low voltage to be used during the exposure of the larynx and a predetermined high voltage during the actual photography. Each voltage range has its own rheostat and may be regulated through a single volt meter. The presetting of each rheostat provides an equal amount of light for all photographic procedures, insuring uniform color. A simple throw switch produces the increase in illumination from one level to the other to facilitate rapid, accurate change in illumination. The battery box circuit is illustrated in Fig. 3.

Two types of camera equipment have been used. The first consists of a 16 mm. Bell and Howell magazine loading camera, a Goerz reflex focuser, and a two-inch $f3.5$ Taylor-Hobson lens. The reflex

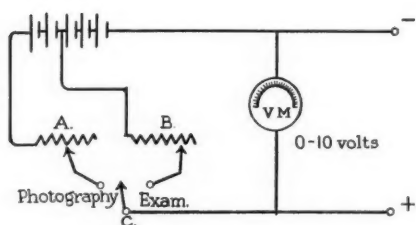


Fig. 3.—Circuit of battery box with toggle switch for low voltage throw to be used during exposure of field and high voltage selection for photography.

focuser, placed between the camera and the lens, serves as an extension tube as well, which is necessary for close work. The only part of this unit which requires special manufacture (Bell and Howell Co.) is a focusing mount which must be substituted for the regular focusing mount of the lens. A small adapter, fastened to the sunshade of the lens with set screws, fits over the proximal end of the laryngoscope to provide a firm, light-tight fitting between the camera and the laryngoscope. Thus, after the larynx has been satisfactorily exposed, the camera is attached directly to the laryngoscope and the field brought into accurate focus by viewing it through the reflex focuser. The larynx may then be photographed as the small prism in the focuser is withdrawn. Frequent, rapid checks may be made of the field and focus through the reflex focuser.

The second type of camera equipment consists of an Eastman Ciné Kodak Special camera with an Eastman two-inch $f3.5$ lens. Since the reflex focuser is built into this camera it is merely necessary to provide an extension tube for close work. It has been found that the base of the series of extension tubes which are provided with this camera may be used alone to bring the field of focus to the tip of the laryngoscope. This camera is attached to the laryngoscope by an adapter similar to that used with the other camera equipment. It is screwed into the lens shield and slips over the proximal end of the laryngoscope. All focusing and adjustment of field are done after the larynx is exposed and the camera attached to the laryngoscope. Immediately before the actual photography, the current to the bulbs is increased by the toggle switch on the battery box.

It should be mentioned that before attempting to photograph the larynx the lens of either of the units described above must be

warmed to a point considerably above body temperature to prevent condensation on the lens. It has been our practice to warm the lens and adapter in an electric heating pad turned to the "low" position, attaching them to the camera immediately before the laryngoscopy is begun. By detaching the lens from the camera while heating it the injurious action of heat on the film is avoided.

SUMMARY

A new laryngoscope and lights are described for routine colored motion-picture photography of the larynx. The cameras and lenses for use with this equipment are described.

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XX

NUCLEIC ACID TREATMENT OF SUBACUTE
AND CHRONIC SINUSITIS*

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In my work in the allergy clinic of the Department of Otolaryngology at Washington University, St. Louis, in the summer of 1936, my attention was called by Dr. R. A. Hetler,¹ dietician in that clinic, to a group of symptoms she called hyponuclemia. She observed that these symptoms occurred most frequently in children under 14 years of age and were due to a lack of nucleoproteins in their diet, or to some faulty digestion of nucleoprotein, or to a nucleoprotein leak in some purulent discharge in the respiratory tract.

The clinical picture described by Hetler was that of a pale pasty complexion, distinct pallor, excess weight, and an appearance of pseudorobustness.

In my work with hyponuclemia the past five years, in connection with infections of the upper respiratory tract, I found the following additional symptoms: loss of appetite, almost anorexia; sluggish mental and physical response; indifference to play and surroundings; soft and unhealthy flesh and a somewhat retarded growth. This clinical picture forms a syndrome that is always evident in well-established cases of hyponuclemia.

The nucleoproteins are a mixture, not a chemical union, of nucleic acid, protein, and phosphoric acid. Their source is in the cellular nuclei of lean meat and all glandular tissue, in whole cereals, and in green vegetables. The thymus gland, the spleen, and the pancreas are very rich in nucleoproteins. The lymphoid tissue in the naso- and oropharynx either stores or produces nucleoproteins, a source of nucleic acid, to supplement a food deficiency that is rarely sufficient after a severe nucleoprotein loss.

When nucleoproteins are ingested orally, gastric digestion splits off a portion of the protein; the pancreatic digestion splits off more

*Presented before the Otolaryngological Section of the Brooklyn Academy of Medicine, May 14, 1941.

or all of the protein. After absorption into the circulation the rest of the protein, if any, is split off and the nucleic acid and phosphoric acid are separated.⁵

This nucleic acid is absolutely essential to the vital intracellular functions. Deprived of nucleic acid, an animal dies as soon as the stored supply is exhausted, which is usually in two or three weeks.

Hyponuclemia usually results from a deficient nucleoprotein diet, a faulty gastrointestinal digestion, or a persistent nucleic acid leak in the sinus and nasal discharges in subacute and chronic sinusitis. This discharge is the largest factor in the production of hyponuclemia. In children the thymus gland and the hypertrophied pharyngeal lymphoid tissue and the enlarged cervical glands are a considerable factor in supplying the deficiency. The hypometabolism as evidenced by the excess in weight and the hypothyroidism as evidenced by the slow pulse and sluggishness are the attempts of the body to conserve the stored nucleic acid for more vital functions.

In children hyponuclemia develops most often from prolonged nasal or prolonged otitic discharge, or from frequently recurring nasopharyngeal infections. A nasal or otitic cerebrospinal leak from a skull fracture will produce a clinical or subclinical hyponuclemia.

Curiously often after hyponuclemia has existed for some time, the patient seems to be unable, by diet alone, to build up the necessary reserve as long as any leak exists.

Briefly stated nucleic acid rapidly increases the white blood count or leucocytes;² it increases their phagocytic activity;³ it increases the opsonic index; it increases the antibody tissue content; it stimulates the detoxifying function of the liver and kidneys. The nephrosis in all these cases is largely, if not entirely, due to the faulty liver and kidney detoxifying functions.⁴ The swollen lower eyelids, the general anasarca, and the ascites in profound cases are characteristic symptoms of this type of nephrosis.

1. In well-defined cases of hyponuclemic syndrome, which has already been outlined, the diagnosis is easily made.

2. The subclinical type must be suspected more from the history than from the symptoms. In all cases of prolonged excessive nasal, postnasal, or bronchial discharge, persistent headache, or slow convalescence from a subacute stage hyponuclemia should be suspected. Patients with frequently recurrent colds will sooner or later develop hyponuclemia.

3. All cases of chronic nasal discharge in children who have no intranasal cartilage or bone obstructive deformity or nasal allergy are of either evident or subclinical type.

4. Stunted growth or lack of vigorous health may indicate hyponuclemia.

CASE REPORTS

CASE 1.—W. W., male, aged 7 years, developed purulent discharge and stuffiness when 2 years of age. Tonsillectomy and adenoidectomy were performed one year later without improvement. During the past four years there has been nasal stuffiness due to a thick purulent discharge and restless sleep and a feeling of suffocation, giving a picture of hyponuclemia. He was given nucleic acid and in ten days there was less discharge and sleep was quiet. Two weeks later he was free from nasal discharge, had a good appetite, and was bright, keen, and active. Six months later he was a normal healthy boy.

CASE 2.—Male, aged 6 years, the exact prototype of the patient in Case 1, had had chronic sinusitis for three years and had been under medical care most of that time. He was definitely hyponuclemic. The tonsils and adenoids had been removed two years before without relief. The picture was one of stunted growth and of mouth breathing due to purulent discharge. Three months of nucleic acid treatment cleared all nasal symptoms, and general health and the nasal condition were good one and one-half years later.

CASE 3.—W. C., male, aged 6 years, had had profuse nasal and postnasal discharge with recurrent colds for four years. Tonsillectomy and adenoidectomy had been performed one year before with persistence of nasal symptoms. He was definitely hyponuclemic and one month's treatment with nucleic acid cleared the nasal and hyponuclemic symptoms. Six months later, having had no treatment in the interval, he was free from colds⁴ and appeared healthy.

CASE 4.—P. F., female, aged 7 years, had had recurrent nasal infections, frontal sinus pains, and profuse nasal discharge for many months. Tonsils and adenoids had been removed and she had been given short-wave treatments without benefit. She was hyponuclemic. The headaches, nasal stuffiness, appetite, and her general health improved rapidly under nucleic acid treatment. She remained free from nasal symptoms during the following year.

CASE 5.—J. S., male, aged 14 years, had symptoms suggestive of perennial nasal allergy. Both nares were occluded by pale, boggy turbinates and there was much mucopurulent discharge and postnasal pus trails. There were no intranasal deformities and the tonsils and adenoids had been removed. He was decidedly hyponuclemic and though 14 years of age gave the appearance of being only 11. Exclusion of inhalants and several foods to which he was sensitive and three months of the usual nasal treatment had given no relief. Nucleic acid was given with improvement of symptoms and increase in growth and keenness and robust health. The following year he reported freedom from colds and nasal symptoms.

CASE 6.—S. L., male, aged 11 years, had a history of recurrent colds and constant nasal obstruction. There were no nasal deformities and the tonsils and adenoids had been removed. Nucleic acid treatment was given for two months with improve-

ment. One year later he reported having been free from colds and having had good general health.

CASE 7.—J. C., male, aged 12 years, had chronic bilateral ethmoiditis and was hyponuclemic. He had received the usual intranasal treatment and many short-wave applications without relief from nasal discharge or obstruction. He was given nucleic acid for two months, the nose remaining clear night and day. Growth, keenness, and school work showed decided improvement.

CASE 8.—J. H., female, aged 13 years, had been under tests and treatment at a large allergy clinic for more than a year without relief from purulent nasal discharge and obstruction. She reported frequent head colds and persistent frontal and temporal headaches. There was no intranasal deformity. She was given nucleic acid and one week later reported no headaches and improvement in nasal symptoms. One month later breathing was normal and the headaches were still absent, and she felt vigorous and energetic for the first time in two years.

CASE 9.—A. M., male, aged 6 years, for four years had been decidedly hyponuclemic. He had been ill most of the time, with retarded growth, poor appetite, and listlessness. He had had two attacks of scarlet fever during the winter of 1940. The family physician ordered tonsillectomy and adenoidectomy, a serious thing to a child in that condition, and I refused to operate until the hyponuclemia was improved. Two weeks of nucleic acid treatment showed marked improvement, and the child stood the operation without incident. He gained one pound a week, showed improvement in growth, and became active and keen. He was been perfectly well in the past ten months.

CASE 10.*—T. D., male, aged 7 years, had had profuse nasal discharge for months from repeated head colds. He was decidedly hyponuclemic. Nucleic acid treatment was given, and after one month there was no nasal discharge, improved appetite, and gain in weight. Some months later he was still normal.

CASE 11.*—A. J., male, aged 14 years, was a marked mouth breather. He had had recurrent colds. The tonsils and adenoids had been removed four years before. The nose was obstructed by mucopurulent discharge and there were boggy turbinates. He was hyponuclemic and was given nucleic acid. One week later nasal discharge was less, breathing was better, and the appetite was increased. In another week he was much improved, breathed better, had only slight discharge, had clear nares, slept quietly, showed improved school work, and had no headaches.

CASE 12.*—A. W. M., female, aged 9 years, for the past few years had had frequent nasal congestion, attacks of dyspnea which usually lasted about a week, and a temperature of 100 to 102° during the attacks. There were mucoid discharge and impacted turbinates. The tonsils and adenoids had been removed four years before. The patient was hyponuclemic. She was given nucleic acid and in a week dyspnea stopped and sleep and appetite improved. One month later the child was free from symptoms and has remained so.

CASE 13.—S. T., female, aged 58 years, had been an invalid for two years with asthma and had been under the care of two hospital allergy clinics and several rhinologists. She had been hospitalized a few times because of the severity of the asthmatic attacks. When I first saw her she was giving herself 1 cc. of adrenalin by hypodermic several times a day. Her diet had been reduced to six foods and

*Cases reported by Dr. William Herbert.

she was emaciated. The dyspnea and cough, day and night, exhausted her. There was no evidence of nasal discharge or obstruction, yet I felt she had bacterial asthma. Most of her body was covered with hives. Because of dehydration, she was given suprarenal cortical hormone, which gave some relief of asthma but did not affect the hives. Shortly after, the asthma increased violently, and for the first time a viscid discharge from a sphenoid was seen. Nucleic acid treatment was added for the first time, and no intranasal treatment was given. In two weeks all signs of asthma had disappeared, but the hives were unaffected. Two months later under nucleic acid treatment she continued to be free from asthma and the hives had gradually lessened. Asthma was absent for two years, when a severe nasopharyngeal infection caused it to return. The nucleic acid cleared the asthma quickly and she remained free for one and one-half years, after which time contact with her was lost.

CASE 14.—D. L., male, aged 50 years, had had such severe asthma for three years that he was unable to work. He had as well viscid postnasal discharge. He was treated with nucleic acid without intranasal treatment and the asthma improved rapidly. He remained free of the asthma for three years after which it returned violently. Adrenalin gave him only slight relief for a few minutes. Treatment with nucleic acid again cleared up the bacterial asthma.

CASE 15.—A. K., female, aged 36 years, ran a low-grade evening temperature and showed weight loss of fifteen pounds in a few weeks. She had considerable postnasal lymphoid tissue and an enlarged tender right parotid gland. Supportive treatment helped for a while only, after which she lost weight and strength rapidly. The third time this occurred she was given nucleic acid treatment because of a persistent low-grade temperature. Recovery was rapid and in a few months she was well, remaining well for three years, at which time an acute pharyngitis caused her to show the same symptoms. Nucleic acid again caused her to show marked improvement and she has remained in good health during the intervening one and one-half years.

CASE 16.—C. H., male, aged 78 years, two years before had had a malignant type of flu, as he had had in 1919. The sinuses and trachea were badly involved. The nasal and bronchial discharges gradually became almost frank pus. After three weeks his condition became alarming and he was given nucleic acid for the first time. Marked improvement was noted within forty-eight hours and he was back at work after two weeks.

CASE 17.—M. A., female, aged 44 years, had had severe perennial allergic rhinitis and ethmoiditis for the past four years, as well as severe early and late hay fever. She had constant headaches, and the nasal mucous membrane appeared typically allergic. She was given nucleic acid to clear up the post-hay-fever seasonal sinus involvement. One week later there was no rhinorrhea or sneezing, the improvement continuing until the onset of pollinosis the following summer.

CASE 18.—V. F., male, aged 30 years, had had severe supraorbital pain following acute purulent rhinitis several weeks before. The left middle turbinate was hyperplastic and obstructive and there was discharge in the left middle meatus and vault and an obstructive vomal spur on the same side. The right frontal sinus by transillumination appeared clear and the left black. He was given nucleic acid. Five days later he reported freedom from frontal pain or sense of head cold and slight discharge. Four days later the left frontal sinus appeared clear by transillumination.

CASE 19.—F. G., female, aged 48 years, had had occipital, temporal, and frontal pain for five years. She had been under medical care during that time, with the pain gradually increasing. She reported difficulty in sleeping, recurrent head colds, and viscid discharge from the left ethmoidal and sphenoidal regions. She was given nucleic acid and no other treatment. In ten days she reported freedom from all pains. Nucleic acid treatment was gradually reduced and four months later she reported no pain and vigorous health.

The foregoing cases are illustrative of the results in nearly 300 cases. Less than 10 per cent of the patients who were free from intranasal deformities, such as spurs, deflections, and advanced polyposis, responded readily to nucleic acid treatment in subacute and chronic ethmoiditis.

During active subacute and chronic sinusitis and hyponuclemia in children under 10 years of age, I gave 10 gr. powders, mixed in water, milk, or orange juice, twice daily, one-half hour before meals, morning and evening, until the nasal symptoms are decidedly improved and the hyponuclemic symptoms are evidently less. Then the nucleic acid is given once a day. This improvement very frequently occurs within a week or ten days. As soon as signs of normality are evident, I give the powders on alternate weeks for two or three months until normality seems to be pretty well established. To patients more than 10 years old, 15 gr. are given. There is no toxic effects from larger doses. The above doses seem to be sufficient, expense precluding an unnecessary quantity.

It is imperative that the patient be put on a diet that is rich in nucleoproteins as soon as the appetite permits. If that diet is maintained, seldom will further nucleic acid treatment soon be required.

Relief by this treatment cannot be expected in acute sinus infections unless a hyponuclemia has preceded the acute attack as the attack is usually too short to have exhausted the stored nucleic acid. It is in the subacute and the chronic sinusitis that one can expect to get the most favorable results.

Fortunately, nasal blockage from intranasal deformity that obstructs drainage and ventilation does not occur in the majority of young children. Hence as soon as the nasal discharge stops, breathing is relatively normal.

Retention of heavy, viscid purulent discharge in the antrum calls for irrigation or drainage. Practically every case of frontal, temporal, and occipital headache or pain was relieved for weeks or months with this treatment, most of them within two or three days. I have not had to infract or remove a portion of a middle turbinal or dilate a nasofrontal duct in the past two years to get relief.

There were practically no failures after extended treatment in favorable intranasal cases. When the nasal blockage was due to intranasal deformity obstructing drainage and ventilation, nucleic acid lessened or stopped the nasal and postnasal discharge, but a recurrent cold soon caused a return of the symptoms. Nasal allergy other than pollinosis, was favorably affected if the antigen present was not too generous. If the allergy was due to a bacterial antigen, the relief was often dramatic.

When sinusitis or acute infection has not existed long enough to deplete somewhat the stored nucleic acid, it is unreasonable to expect a decided effect. One percent nasal spray of ephedrine on the first few days of treatment to help maintain drainage will quicken results, but its use is rarely necessary for more than three or four days. In every case of prolonged infection that is at all toxic, suprarenal cortical hormone given orally is an advantage as it has been demonstrated that a toxic condition quickly produces a deterioration of that gland and hence a diminished secretion of its hormone. This always produces varying degrees of dehydration. The sluggish mental and physical condition and a slow pulse and a lower afternoon temperature indicate a thyroid hormone lack that always accompanies dehydration, due to the suprarenal cortical hormone lack. Nucleic acid alone will get results, but the addition of these accessories will quicken their attainment.

SUMMARY

1. Because of the simplicity of the treatment, opposition to the office treatment is eliminated.
2. Only two or three weekly visits and four or five monthly visits, which children do not object to because the Dowling treatment is absent, are necessary in the majority of cases.
3. Not only nasal and upper respiratory infections clear up but likewise cervical adenitis.
4. The general health and growth are markedly improved.
5. For the maintenance of improved nasal and general health, a diet rich in nucleoproteins must be maintained.
6. In a large percentage of children treated, cold and reinfections were markedly reduced.
7. If nucleic acid treatment is given ten days to two weeks before a tonsillectomy and adenoidectomy in markedly hyponuclemic children, the toxemia is lessened, convalescence is shortened, and a

hyponuclemia that did not exist before is prevented. These are the cases in which mothers complain that the child has been worse since the operation.

8. Nucleic acid gives results only when a deficiency exists.

Practically every treatment of chronic sinusitis in the past 20 years, except Proetz' displacement and the Dowling pack, gave relief by destroying tissue, either the deeper cavernous or the superficial mucous membrane. This destruction diminished the functional efficiency of the nose or resulted ultimately in an atrophic condition that made the nasal lumen functionally as useful as a bung hole. A dry nasal mucous membrane added to the discomfort.

In contrast, nucleic acid marshals the defensive and offensive elements of the blood and endocrines to destroy the infections without in any way destroying or lessening the functional capacity of any tissue in the upper or lower respiratory tract that existed at the time of the treatment. In fact, the functional capacity is increased by the elimination of the infection and the very decided improvement in the general health and sense of well being.

41 EASTERN PARKWAY.

For the opportunity and the material to do this work, I am deeply indebted to the Brooklyn Eye and Ear Hospital and especially to Dr. William Herbert in whose clinic this work was done.

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DIAGNOSIS AND TREATMENT OF CANCER
OF THE LARYNX*

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Cancer of the larynx remains the foremost problem in laryngology at the present time. There are scattered references to the subject in the literature before 1855. It was in 1855 that Garcia demonstrated the possibilities of laryngoscopy and in 1858 that Czermak further advanced the art, after which the disease was more often recognized and methods of treatment instituted. From the early days when diagnosis was inaccurate and treatment unsatisfactory until now, the subject has been one of marked controversy. Certain well-established facts are now generally accepted in regard to diagnosis and treatment, though there are still numerous opinions as to the best method of treatment.

The purpose of this paper is to review the established facts and salient features of this important subject and to present eighteen consecutive operative cases, the results of which tend to confirm recognized principles as advocated by leading laryngologists of long experience.

Cancer of the larynx is actually and relatively on the increase, keeping pace with the general increase of cancer which is today accorded second place as the most common cause of death. The summary of vital statistics for 1938 shows a mortality of 1,340 cases of cancer, and an increase of 841 cases since 1920. As cancer is not a reportable disease in all communities, though it should be, as advocated by many, these records can only be judged as an indication of the increasing incidence. In order to obtain reliable statistics, all cases regardless of extent or method of treatment should be reported.

It is estimated that 4 per cent of all cases of cancer occur in the larynx. Men are more often affected than women in the ratio of nine to one, the disease being most common during the fifth and

*Presented as a candidate's thesis to the American Laryngological, Rhinological and Otolological Society.

sixth decades. Occasional cases have been reported in those under 25 years of age, but they are extremely rare. Postcricoidal cancer, which constitutes a very small percentage of cases, is seen more often in women.

The etiology of cancer of the larynx remains one of the unsolved problems of medicine. Chronic irritation and vocal abuse are generally accepted as contributing causes. Alcohol and tobacco are also considered important factors.

Through the years cancer has been classified anatomically as being intrinsic, extrinsic, and subglottic, as first suggested by E. Isambert in 1876, but there have been varied interpretations as to the dividing line and whether the classification denoted the point of origin of the growth or the limits of extension. Since the general acceptance of Broder's histologic classification of cancer into four groups or grades, denoting largely differentiated, intermediate, and undifferentiated types of cancer, the trend has been to classify the disease according to its point of origin, clinically and histologically. In the very extensive lesions it is often difficult to determine the exact point of origin though the grade of the tumor may readily be determined histologically.

Radiologists are inclined to omit the terms intrinsic and extrinsic and to speak of the disease according to the area specifically involved, as best can be determined. Coutard has classified it into three groups clinically: cancer of the vestibule and ventricular cavity, cancer of the glottis, and cancer of the subglottis.

The first, or supraglottic cancer, is subdivided into two types: (1) That which originate in the region of the pharynx and is generally an epithelioma of mucous membrane type. (2) That which originate in the middle and inferior zone of the vestibule and ventricular cavity. It is generally a stratified epithelioma arising from cylindric metaplastic epithelium.

Histologically he considers two main varieties of laryngeal cancer: "Cancer composed of undifferentiated cells having a great tendency to early and widespread dissemination in the loose vascular connective tissues and cancer composed of differentiated cells having a special affinity for the muscles and an immobilization of muscle without any tendency to dissemination."

Although this seems very logical and is being adopted more or less by a few laryngologists, the majority are still inclined to use the classification of intrinsic, extrinsic, and subglottic lesions with

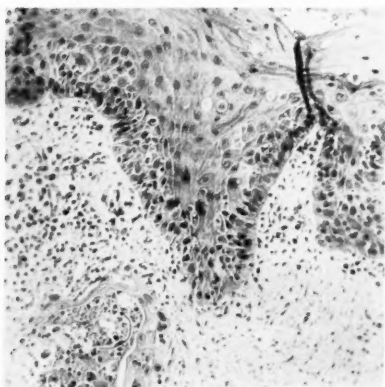


Fig. 1.—Very early carcinoma of the larynx. Beginning downward growth of the epithelium, occasional mitoses, and one degenerating hornified mass in the subepithelial inflamed stroma. (x100.)

more uniform understanding as to the dividing line between extrinsic and intrinsic cases. Hayes Martin has recently suggested that the free border of the ventricular bands, which are rarely the original site of cancer, be the dividing line between the extrinsic and intrinsic larynx. All growths originating on the upper surface of the ventricular bands and above, including the aryepiglottic folds, arytenoids, epiglottis, and postcricoid area, would constitute extrinsic cancer and those arising below would constitute the intrinsic group, including the ventricles, cords, and subglottic lesions.

In the vast majority of cases, the earliest symptom is some degree of hoarseness. This is quite natural as the vocal cords are usually the first structures affected. The change in voice is most frequently a slight intermittent hoarseness, which becomes worse after excessive use. This gradually progresses to a constant and marked hoarseness and finally complete aphonia. There are rarely other symptoms during the first six months or year of cancer originating in the intrinsic larynx. In advanced stages there are varying degrees of dyspnea, cough, and blood-streaked sputum, associated with general symptoms of advanced cancer.

When the disease arises in the ventricular or subglottic region, symptoms may not be evidenced until well advanced and the process

has extended to the vocal cords producing hoarseness or into the glottis producing partial obstruction or has metastasized to the cervical glands.

In extrinsic cases the early symptoms consist of tickling, irritative feeling, sensation of a lump, excessive mucoid secretion, clearing of the throat, slight dysphagia or odynphagia. So commonly symptoms of ordinary laryngeal and pharyngeal disorders they are easily overlooked until more advanced when pain, often referred to the ear, dysphagia and odynphagia, dyspnea, bloody sputum, and masses in the neck occur. Cough is a variable symptom and is usually due to secretions overflowing into the larynx.

Early diagnosis is of paramount importance in cancer of the larynx, as cancer of this region is more amenable to treatment than cancer in any other internal area of the body, when diagnosed early. Although laryngologists have repeatedly stressed this point, only about 20 per cent of the cases are now seen sufficiently early to avoid radical treatment. This can only be attributable to the fact that there is too much watchful waiting, spraying and swabbing throats, before complete and competent laryngeal examinations are invited. Every individual with persistent hoarseness should have a careful, complete laryngeal examination and should be kept under observation until a definite diagnosis is ascertained, after which appropriate treatment can be rendered.

It is universally recognized that well over 85 per cent of the cases occur in the anterior half of the larynx, most frequently on the vocal cords and less often in the anterior commissure. The disease always originates on one cord and involves the opposite cord by extension across the anterior commissure. Approximately 98 per cent of these cases are squamous-cell or epidermoid carcinomas. Papillary carcinomas constitute a small percentage of cases. Endotheliomas and sarcomas have occasionally been reported.

Impaired motility or complete fixation of a vocal cord in the presence of cancer is now generally considered evidence of an advanced and infiltrative lesion.

Next to cordal cancer the most common site of origin is the subglottic region, then the extrinsic lesions, and in very small percentage of cases it arises in the laryngeal ventricle. It is thought by some that subglottic lesions are more common than generally recognized, but unless the lesion is seen before the cord is involved, it is very difficult to say whether it originated in the subglottic area and extended to the vocal cord or vice versa.

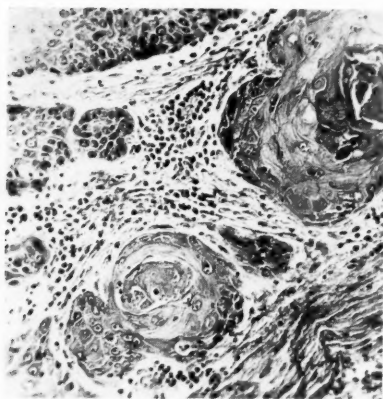


Fig. 2.—Epidermoid carcinoma, Grade I. Tumor cells fully differentiated into hornified masses and pearls. (x100.)

Diagnostic procedures consist of the taking of a careful history, noting especially the duration of symptoms, mirror laryngoscopy, palpation of the neck and larynx, roentgenograms of the chest, serologic tests, direct laryngoscopy, and a representative section of tissue for histologic study.

Mirror laryngoscopy should not be considered complete until the entire larynx has been visualized. On indirect examination, the motility of the cords, color of mucous membrane, contour of the larynx, and the character of the lesion should all be carefully noted.

Early intrinsic carcinoma may occur as a superficial infiltrating type of lesion, a warty or papilla-like growth or diffuse and deep invasive type of lesion. The former is probably the most common, appearing as a reddish elevation of the surface or margin of the middle or anterior half of the vocal cord or in the anterior commissure. Papillary growths usually occur on the margin of the cord, are red or pinkish in color, and extend into the glottic lumen. They most often have a broad base and are rarely pedunculated.

Diffuse and deep infiltrating lesions usually involve the greater part of the cord and appear as a thickened red vocal cord without any tumor formation.

Though the color of the lesion is usually some degree of redness, they may be moderately pale, simulate the surrounding mucosa,

or show different shades of color and congestion depending largely on the degree of secondary infection. Ulceration may occur very early or not until late when the disease is further advanced and more extensive invasion has taken place. In certain cases the surface of the cord may appear granular or roughened, with a whitish exudate which may be patchy or uniform. Cancer of this region grows slowly and may be present for one or two years before marked symptoms develop. They metastasize late due to the poor lymphatic supply to the intrinsic larynx and to the surrounding protective barrier of cartilage.

As the disease progresses it extends in all directions. It may first involve the ventricle or subglottic region on the original side or may cross the anterior commissure to the opposite cord before more extensive invasion in other directions. With further extension the entire larynx may become involved before metastasis occurs, presenting an extensive ulceration and obstruction of the intrinsic larynx.

Growths originating in the ventricles, which are considered very rare, are first seen as a smooth elevation of the false cord or there may be papillary projections from beneath the false cord. Later stages show more definite tumor formation, ulceration, and evidence of extension. These growths metastasize earlier to the cervical glands by way of the superior laryngeal lymphatics.

Primary subglottic lesions grow beneath the mucosa and if seen fairly early appear as reddish, smooth, subglottic elevations usually in the anterior region. Later they appear as an infiltrating, ulcerated mass extending into the subglottic and tracheal lumen. There is a tendency to widespread infiltration, cartilage destruction, and early metastasis to the trachea, esophagus, and glands of the neck.

Extrinsic lesions may appear as irregular excavative ulcerations or large cauliflower-like growths. Occasionally they may obtain large size before ulcerating and appear smooth and pale in color. They grow rapidly and metastasize early due to the abundant lymphatic supply to this region.

Lateral roentgenography, though not essential for diagnosis, is considered a valuable adjunct in many large clinics. With the development of tomography of the larynx by Le Borgne, more definite and accurate information can now be obtained. This is a definite advance in diagnostic procedure and is of especial importance in determining the inferior extension and outlining the limits of the growth, which is sometimes difficult even by direct laryngo-

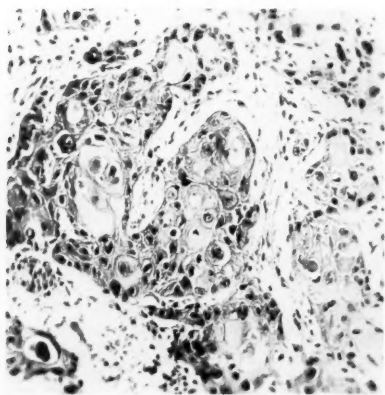


Fig. 3.—Epidermoid carcinoma, Grade II. Cells proliferating in disorderly manner, variation in size and shape of the cells, atypical mitoses and considerable hornification. (x100.)

scopy. Unfortunately tomography is not generally available, due to expensive equipment, and I have not found roentgenograms of the larynx, by the usual technic, to show sufficient detail to be of any definite assistance.

Direct laryngoscopy should be performed in all cases where malignancy is suspected or where a tentative or definite diagnosis has been made by mirror laryngoscopy. It is only by this means that the character and extent of the lesion can be more carefully studied and a representative biopsy more accurately and skillfully obtained. I prefer Jackson's method which can be performed easily and quickly under local anesthesia without undue risks to the patient.

For years the question of biopsy was debatable, but for the past ten to fifteen years it has been generally accepted as being necessary not only for diagnosis or confirmation, but also for determining the grade of the tumor, according to Broder's classification, which is now recognized as an essential factor in prognosis and therapy. It has also been proven that obtaining a biopsy does not cause any dissemination of the disease, though it is not advisable to postpone treatment longer than is absolutely necessary. In clinically suspicious cases, if a biopsy is reported to be negative, repeated biopsies should be obtained and sections studied serially.

All growths removed from the larynx should be examined histologically for quite often an apparently benign looking tumor will prove to be malignant. In all cases, histologic examination is the final arbiter and obtaining a biopsy should not be delayed too long in suspicious cases.

Histologic information has demonstrated that cancer of the vocal cords consists of highly differentiated cells and it is usually classified as Grade I or II. Subglottic, primary ventricular growths, and extrinsic lesions are usually composed of poorly differentiated cells and grouped into Grades III and IV. With increased interest and knowledge in radiology in regard to the larynx, it has been found that the highly differentiated groups are radio-resistant while the undifferentiated cases are radio-sensitive. This comparatively recent histologic and radiologic knowledge has greatly influenced the prognosis and treatment.

Tuberculosis and syphilis have long been considered the most common diseases from which cancer must be differentiated. Differential diagnosis is accomplished in the majority of cases by serologic tests, sputum examinations, roentgenograms of the chest, and the character of the lesion. Chronic laryngitis in adults may present one of the most perplexing problems. In a known case of chronic laryngitis, any increase in symptoms or progressive changes in clinical appearance may be the indication of malignant changes. Cancer must also be differentiated from leucoplakia, which is considered a definite precancerous lesion, hyperkeratosis, pachydermia, and papillomas. Although the last are sometimes considered precancerous, it cannot always be definitely demonstrated. It is well known that cancer may develop on the site of a previous benign papilloma and that apparently benign papillomas may develop malignant changes and become papillary carcinomas. In any case biopsy and histologic examination is the final analysis. It is possible that tuberculosis or syphilis may occur simultaneously with cancer though this is a very rare condition.

Cancer of the larynx, in suitable cases, has been successfully treated for the past forty years by surgery, with increasing and encouraging results. Laryngofissure and laryngectomy have been the basis for surgical procedures with many modifications for the former and varied technic for the latter. Although the first laryngofissure for cancer was performed by Sands in 1863 and the first laryngectomy by Billroth in 1873, results before 1900 were not as a whole very spectacular and operations were attended with a high mortality.

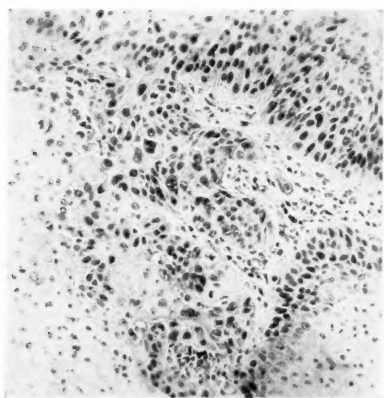


Fig. 4.—Epidermoid carcinoma, Grades II and III. Actively proliferating cells with scattered mitoses and only moderate hornification. No pearls. Cells rather small. (x100.)

Of utmost importance in successful treatment is early diagnosis and the excision of at least 1 cm. of normal tissue surrounding the growth. New and Fletcher have shown that there is an average extension of 5.5 mm. in all grades of cancer from the apparent margin of the growth, and in Grade IV types it may be as great as 15 mm. The complete removal of the growth with its surrounding area of normal tissue should be the first consideration, and the conservation of the voice and larynx second.

There is no standard method of treatment, but each case must be judged individually. The age of the patient, life expectancy, duration and extent of the lesion, histologic grade, question of metastasis, and surgical risk of the patient are factors all laryngologists consider in selecting the best method of treatment.

Within the last few years radiologists claim results equal to those of surgery in the treatment of early cordal cancer by Coutard's method of protracted fractional irradiation. They claim better results than surgery in the treatment of primary ventricular and extrinsic lesions and consider the prognosis poor in extensive subglottic or metastatic lesions by either method. Coutard states: "We now know that cancers of undifferentiated cells, extremely fragile, can be cured by all varieties of irradiation, while cancers of very differentiated and infiltrating cells are only exceptionally cured."

There are those at the present time who favor irradiation, those who favor surgery, and those who favor a combination of the two. However, laryngologists are unanimous in the opinion that surgery for primary intrinsic cancer of the larynx is the most effective treatment.

Endoscopic removal of cordal cancer is not generally considered advisable, though occasionally successfully treated cases by this method have been reported. For successful removal the lesion must be extremely early, localized, and limited to the margin of the cord. One such case is reported with excellent results and no evidence of recurrence after four years.

The majority of laryngologists consider laryngofissure the ideal operation for early intrinsic cancer, regardless of the grade, where only one cord is involved, where there is no extension to the posterior larynx or subglottic area, and where no impairment in motility of the cord exists. The growth can be completely removed, the larynx conserved, and a good servicable voice developed. St. Clair Thomson and Chevalier Jackson have advocated this procedure for over twenty-five years, reporting 80 per cent cures with very low mortality. Tucker and Clerf have also reported excellent results by this method, but it has only been within the past ten or fifteen years that it has become generally accepted by leading laryngologists who now confirm the excellent results obtainable.

Chevalier and Chevalier L. Jackson have advocated the removal of anterior commissure growths by this route for years according to their special technic, and have reported results equal to those in cordal cases.

In slightly more advanced cases where there is beginning subglottic extension from the cord or the lesion has reached the arytenoid and there is little impairment in motility, good results are obtainable by the laryngofissure route with removal of the arytenoid and in some instances the overlying thyroid cartilage. This amounts to a hemilaryngectomy, but it is more desirable, when possible, than complete laryngectomy.

Total laryngectomy is advocated for more advanced cases of intrinsic origin, where there is definite impairment in motility or complete fixation of one or both sides, extension to the ventricles and undersurface of ventricular bands, or subglottic extension which approaches the cricoid cartilage. Laryngectomy is also recommended for primary subglottic cases provided there is no glandular metastasis and the malignancy is of low or intermediate grade.

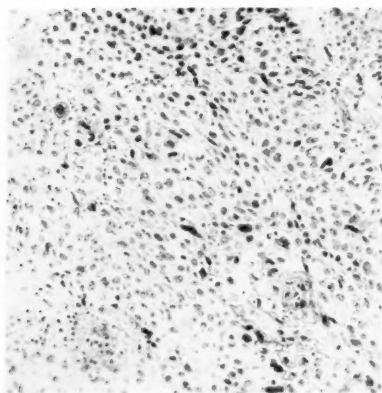


Fig. 5.—Epidermoid carcinoma, Grades III and IV. Small cells in diffuse growth with very little differentiation. No hornified masses or pearls. Mitoses numerous. (x100.)

If extension has involved the arytenoids or aryepiglottic folds, only to moderate degree, and the grade of malignancy is low or intermediate, laryngectomy may be performed with fair hope of success. When there is extensive involvement of the vestibule, including the base of the epiglottis, arytenoids, and aryepiglottic folds with or without metastasis to the glands of neck, surgery has met with little permanent success and recurrences have been common. Radical resection of the glands of the neck with postoperative radiation has failed to show notable results. However, there are still those who advocate, in advanced cases, surgery combined with radium or roentgen-ray therapy, with occasionally surprisingly good results.

Laryngectomy definitely remains a justifiable operation and in suitable cases offers 50 to 60 per cent cures, with a low mortality between 2 and 5 per cent, depending largely upon the type of case. Those who favor laryngectomy for early as well as advanced cases report even a higher percentage of cures.

Primary extrinsic lesions and those from extension of high grade malignancy, formerly treated by total laryngectomy and lateral transthyroid pharyngotomy, usually with poor results except in very early cases which are comparatively rare, Chevalier and Chevalier L. Jackson, Clerf, Hayes Martin, and other prominent laryngologists now believe are best treated by irradiation.

Within recent years the question of whether radiation or surgery is indicated in all types of cases has assumed such importance that it seems appropriate to quote the views of a few prominent laryngologists.

Chevalier and Chevalier L. Jackson in their recent book *Cancer of the Larynx*, which is the most complete treatise yet produced on the subject, state: "In intrinsic squamous growths of limited extent and of any grade of malignancy, laryngofissure gives such good results, as regards both freedom from recurrence and postoperative condition of the patient that we could not conscientiously advise irradiation except in patients who are poor operative risks because of organic disease, or whose general life expectancy is unduly short. In cases of extensive but still intrinsic growths of Grades I and II we would advise laryngectomy if the patient is in good general condition and of average expectancy apart from the laryngeal cancer. Broadly stated it may be said that the roentgen ray is exceedingly well suited to the treatment of extensive growths that have become extrinsic by extension and whose intrinsic part shows little cellular differentiation, Grade IV especially."

For primary extrinsic growths, they state: "Irradiation is usually the method of choice in these cases regardless of the grade."

Arbuckle in a recent article states: "At present reported results of treatment of cordal cancer by radiation therapy alone do not equal the results obtained by surgical removal."

Hayes Martin states in speaking of cancer of the extrinsic larynx: "For this group of cases there can be little question that radiation is the method of choice, since these growths can seldom be removed with a safely wide margin by the standard forms of total laryngectomy. Lateral pharyngotomy as popularized by Trotter, has not proven satisfactory in thoroughly removing growths in this region."

He further states: "It is barely possible that improvement in radiation technic may eventually permit the treatment of radio-resistant cancer of the vocal cords, but the fair minded radiologist, who is competent to apply either radiation or surgery, will concede that at the present time no technic has been developed for the treatment of radio-resistant cordal cancer which approaches surgery in its ability to cure."

Clerf stated in a recent presentation to the American Triological Society: "The results of surgical treatment of cancer originating



Fig. 6.—Intrinsic laryngeal lesions. A. Superficial ulceration anterior half of left vocal cord. B. Small papillary carcinoma on margin of right vocal cord. C. Diffuse deep infiltration with granular surface of right vocal cord.

outside of the larynx have been unsatisfactory and I believe irradiation should be employed."

Sir St. Clair Thomson states: "In all cases where surgery can hold out good promise of lasting cure, it must still be given the preference."

In presenting an analysis of eighteen consecutive operative cases, attention is called to the fact that this is a preliminary report, in as much as sufficient time has not elapsed for results to be emphatic except in a few cases. This group represents those cases seen within the past eight years in which surgery was deemed advisable. Some other thirty odd cases observed during this period were either inoperable or not suitable for laryngofissure and laryngectomy was refused. Roentgen-ray therapy in those patients who reported regularly for treatment proved unsuccessful in the majority of instances. It has proven very beneficial in two cases in this series where there were recurrences in the lymph nodes of the neck.

The operative cases consist of seven laryngofissures, one endoscopic cordectomy, and ten laryngectomies. There have been no mortalities from operation and only four recurrences, all of which were in the laryngectomy series. Two of these cases proved fatal, recurring three months and one and one-half years following operation. Radiation therapy was given in each instance, but the former lived only six weeks and the other four months after recurrence

was first noted. One case recurred in a lymph node on the side of greatest involvement eight months after operation. The gland was removed and roentgen ray therapy given. This patient has remained well for one year and three months since recurrence or about two years since initial operation. In the remaining case of recurrence malignant glands developed in the neck opposite the tracheostomy, corresponding to the side previously involved. Protracted and fractional radiation produced a disappearance of the glands and the patient has remained well for eight months since recurrence, or ten months since operation.

There were five males and two females in the laryngofissure group, the youngest being a woman 31 years of age and the oldest a man 63 years of age. All presented a low-grade malignancy, except the youngest who had a Grade III cancer. The duration of symptoms varied from two to eight months, one patient giving a history of intermittent hoarseness for two to three years, but which had only been constant for three months before examination. The right cord was involved in four cases and the left in three. All cases were unilateral except the one with Grade III malignancy, which presented a pinkish papilla-like growth along the margin of the left cord and crossing the anterior commissure and extending to the anterior extremity of the right cord. In three cases the entire cord was red and thickened with superficial ulceration of the anterior third. There was marked congestion in one, covered with yellowish white patchy exudate from the anterior commissure to the vocal process. Another case showed only a red, thickened cord with a slight uneven margin and granular surface. There was no impairment in motility in six cases while one was moderately sluggish. There was no gross subglottic or ventricular extension. Biopsy obtained in each case was reported as epidermoid carcinoma, three being Grades I and II and three Grade II.

Laryngofissure was performed under avertin anesthesia in all cases, the surgical technic as advocated by Chevalier Jackson and Chevalier L. Jackson being followed. It is a strange coincidence but each of the female patients had to have a tracheotomy. In one, the first of this series, it was necessary to remove the arytenoid in order to obtain sufficient surrounding normal tissue. The tracheotomy tube was left in place for four weeks after which it was removed and the patient never had any further trouble. She has developed a strong whispered voice audible over the phone and has been well for six and one-half years. All of one cord and one-half of the other were removed in the youngest female who had a Grade

III malignancy. This has only recently been performed and the patient has not yet been decannulized. The other five patients had only one cord removed with tip of the vocal process and tip of the opposite cord.

Other than the tracheotomies in the two cases there have been no serious postoperative complications. Avertin has proven a splendid anesthesia and I have seen no bad after-effects. A serviceable voice has been developed in every instance and there have been no recurrences to date.

Although endoscopic removal of cordal cancer is not generally considered advisable, evidently because so few cases are seen sufficiently early, one patient has been treated by this procedure with



Fig. 7. Endoscopic laryngeal view of extensive carcinoma of right side of larynx.

excellent results. A man, 67 years of age, gave a history of hoarseness for three to four weeks. Mirror laryngoscopy revealed a small reddish elevation on the margin of the right vocal cord at the junction of the middle and anterior thirds of the larynx. There was beginning ulceration at the tip of the elevation. Biopsy was obtained with biting forceps and reported as early epidermoid carcinoma. The remaining portion of the vocal cord was normal in appearance. A cordectomy was performed several

days later under local anesthesia, using moderately large biting forceps through an anterior commissure laryngoscope. The first section obtained revealed malignancy in the center without activity at the margins. Other sections were negative for cancer. This patient has been kept under close observation for four years and it is now difficult to tell the cord has been removed. There is good motility and an excellent voice has developed.

In the laryngectomy series all patients were males in the fifth and sixth decade. There was nothing significant in regard to an etiologic factor in any of the cases reported. Alcohol and tobacco had been used in moderation by nearly all the males, and alcohol in excess by only two. It is difficult to see where either could have played any definite part.

Hoarseness was the most prominent symptom in this series of ten cases. It varied in duration for eight months to four years and in four cases there was considerable difficulty in breathing for

TABLE I
SEX AND AGE AT TIME OF OPERATION

Age	20-30	30-40	40-50	50-60	60-70	70-80
Laryngofissure						
Male	0	0	1	2	2	0
Female	0	1	0	1	0	0
Laryngectomy						
Male	0	0	0	5	4	1
Female	0	0	0	0	0	0
Endoscopic cordectomy						
Male	0	0	0	0	1	0
Female	0	0	0	0	0	0
Youngest patient		Female 31			Laryngofissure	
Oldest patient		Male 72			Laryngectomy	

TABLE II

DURATION OF HOARSENESS IN PATIENTS OPERATED UPON
BY LARYNGOFISSURE AND LARYNGECTOMY

	Laryngofissure	Laryngectomy
1-5 months	5	—
7-8 months	1	—
8-12 months	1	3
2 years	—	5
4 years	—	2

two to four months. Blood-streaked sputum had been present in two cases. Loss of weight and anorexia were evident in all cases. It is incredible to believe that after forty years of recognition and successful treatment in suitable cases, the general profession and laity are unaware of the seriousness of hoarseness and allow these individuals to go one or two years before seeking consultation.

Nearly every case in this group showed marked advancement, involving the intrinsic and extrinsic larynx in all but two cases. In four cases it was impossible to visualize the cords due to an obstructing, reddish friable ulcerated mass in the supraglottic region, involving all supraglottic structures. The lesion was unilateral in all except one case in which there was extensive bilateral involvement. Four cases presented a reddish ulcerated tumor involving the cord, ventricle, ventricular band and subglottic area for 1 to 2 cm. with edema of the arytenoid aryepiglottic fold. In two cases there was a large subglottic indurated ulcer continuous with a thickened, red, and somewhat friable vocal cord. Due to the extensive subglottic ulceration it is probable that the growth originated in this area and extended to the cord.

After laryngectomy in one case it was found that the supraglottic growth involved primarily the ventricular band, arytenoid, aryepiglottic fold, and the base of the epiglottis with only slight involvement of the cord and ventricle. This case was apparently of extrinsic origin and the only one in the series. At the time of operation the prelaryngeal muscles were found firmly adhered together and to the larynx. It was thought the disease had extended through the pre-epiglottic space or cartilage, though previous examination had shown no external manifestation except a suggestive prelaryngeal thickening. The adherent mass was widely excised and histologic study revealed no evidence of cancer but only inflammatory changes. The underlying cartilage was intact. This patient made a normal recovery and has been living and well for one year.

There was complete fixation of the side involved in every case and considerable narrowing of the glottis in all but two cases. Epidermoid carcinoma was reported in each case, eight being Grade II, one Grades II and III, and one Grade III.

The two fatal recurrences were of Grade II malignancy. One case with recurrent lymph node was of Grade III. This patient is now living and well one year and three months following the removal of lymph node and roentgen-ray therapy.

Previous to operation there was no evidence of glandular metastasis, involvement of the pyriform sinus, postcricoid area, or hypopharyngeal wall. In several cases it was a problem whether operation was advisable or not, but due to the low grade of malignancy, no evidence of above extension, and the fact that results by radiation

TABLE III

SELECTED PATIENTS OPERATED UPON BY LARYNGOFISSURE

Number of patients	7
Operative mortality	0
Recurrences	0
Patients living and well since operation	7
1 living and well	6½ yr.
1 living and well	4½ yr.
1 living and well	3½ yr.
2 living and well	3 yr.
1 living and well	2 yr.
1 living and well	6 mo.
Motility of vocal cords	
No impairment	6
Impairment but not fixed	1
Type and grade of malignancy	
Epidermoid carcinoma	7
Grades I and II	3
Grade II	3
Grade III	1

TABLE IV

PATIENTS OPERATED UPON BY LARYNGECTOMY

Number of patients	10
Operative mortality	0
Primary intrinsic cancer, extensive involvement	9
Primary extrinsic cancer	1
Intrinsic with extension to extrinsic larynx	8
Recurrences (metastasis to neck)	4
After 2 mo.	1
After 3 mo.	1
After 8 mo.	1
After 1½ yr.	1
Death following recurrence, all treated by irradiation	2
Patients living and well since operation	8
1	5½ yr.
2	3 yr.
2	2 yr.
1	1½ yr.
1	1 yr.
1	Less than 1 yr.
Type and grade of malignancy	
Epidermoid carcinoma	10
Grade II	8
Grades II and III	1
Grade III	1

in these types of cases had been very unsatisfactory, laryngectomy performed. At the present time one patient is living and well after five and one-half years, two after three years, two after two years, and three after less than one and one-half years.

Laryngectomy was performed under avertain anesthesia in all cases without mortality or serious postoperative complications. Mackenty's technic was followed in two cases, but the last eight have been performed using a midline incision, which I have found to be very satisfactory. The scope of this paper does not permit a detailed description of the technic, but briefly it consists of skeletonizing the larynx, ligation of the superior and inferior laryngeal vessels, severing the larynx from the trachea, and conserving as much of the cricoid cartilage as safety permits. The larynx is dissected upward and removed by excising around the superior border. The severed end of the trachea is sutured in the midline of the neck, the pharyngeal opening closed with mattress sutures, and the fascia and muscles brought together in the midline. A feeding tube is inserted through the nose before closing the pharyngeal opening. Hard rubber tube drains are inserted through stab wounds on each side of the midline incision opposite the upper and lower extremities. They are left in place for three or four days and then removed. Small fistulas occurred in four cases but gradually healed in three to four weeks. Subperichondrial resection of the larynx, as suggested by Crowe and Broyles, is of definite advantage when possible, and was performed in two cases.

* These patients have all overcome the initial depression associated with the thoughts of such an operation and are now leading happy useful lives. One patient has developed an excellent stomachic voice and the others have an audible and understandable whispered voice. All have learned to use the artificial larynx, as manufactured by Bell Telephone Company, to advantage and are apparently quite pleased with their accomplishments.

The development of an esophageal or stomachic voice should be encouraged in all laryngectomized patients. Increasing interest is being shown along this line and remarkable results have been obtained in many cases.

In closing, I would like to emphasize again the urgent necessity for early diagnosis. It is only by this means that the percentage of cures can be increased and the well-established surgical principles now in use be further utilized to advantage.

SUMMARY

1. Early diagnosis is of paramount importance for the successful treatment of cancer of the larynx.

2. Hoarseness is the most prominent symptom in the vast majority of cases and calls for early laryngeal examination.

3. Primary intrinsic carcinoma originates on the anterior half of the vocal cords in over 85 per cent of the cases. The malignancy is usually of low or intermediate grade. Grade IV has not been encountered in more than fifty cases.

4. Laryngofissure is the ideal operation in comparative early cordal cancer where there is no impairment in motility of the cord and very little subglottic or posterior extension.

5. Laryngectomy is indicated for advanced intrinsic lesions without metastasis and radiation therapy for all primary extrinsic lesions and inoperable cases.

6. Eighteen operative cases are reported: seven laryngofissures, one endoscopic cordectomy, and ten laryngectomies.

7. No operative mortalities and four recurrences in the laryngectomy series, or 22 per cent recurrence in the entire series, are reported. There were no recurrence in laryngofissure group.

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The photomicrographs were prepared and interpreted by Dr. Everett L. Bishop of Atlanta. Dr. Bishop has rendered pathologic reports on all cases reported.

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THE PRESENCE AND ACTION OF LYSOZYME
IN THE NASAL MUCOSA*

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A local resistance of the nasal mucosa to bacteria is suggested by the fact that the upper parts of the nose contain far less bacteria than might be expected, that artificially introduced bacteria may disappear quickly from the surface of the mucosa, and that accidental and surgical wounds rarely become infected. Besides mechanical action of the ciliated epithelium and the drainage, lysozyme (A. Fleming, 1922) can be considered one more factor in the mechanism of local tissue resistance.

From the extensive literature on lysozyme, which recently has been reviewed by Thompson in the *Archives of Pathology*, 1940, some facts concerning the conditions in the nose were discussed. Demonstrations carried out before the society included the clearing of a suspension of a Sarcina, *Micrococcus lysodeikticus* by nasal secretion, methods of estimation and quantitative measurement of the lysozyme content of nasal mucus and saliva, the unchanged lytic power of nasal secretion after storage for nine months even when dried and exposed to light.

The lysis of the test bacteria by nasal secretion is inhibited in acid reaction at pH values which may occur during the daily and seasonal swings of the pH on the surface of the nasal mucosa (W. F. Peterson). In acid reaction only the first phase of the lysozyme action takes place in the way of adsorption to the bacterial surface, but without dissolution of the bacterial cell. The second phase, the lysis, occurs immediately after neutralization of the nasal secretion; but already by adsorption to the surface and by the action of the enzyme on the cell membrane, the germs may be killed without being dissolved. Thus nasal secretion under certain conditions can kill soluble bacteria without dissolving them; on the other hand

*Presented before the Chicago Laryngological and Otological Society, Monday, Oct. 6, 1941.

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some pathogenic bacteria, which can not be dissolved by lysozyme, can be killed nevertheless.

In the dissolution of the bacteria by nasal secretion, the lysozyme becomes free again. It is not used up as bacteriolytic amebocceptors in the serum are, and it is ready to dissolve more bacteria, when such are added. In this way forty million *M. lysodeikticus* were dissolved eight times in succession by nasal secretion diluted thirty-two times with saline solution. Lysozyme action is different from phage action.

Studies were made on the lysozyme content of nasal secretions in healthy individuals. The nasal mucosa, taken from the septum and the turbinates, as well as the cartilage of the septum contain much lysozyme. Daily quantitative measurements were made in one individual during one month. After irritation of the nasal mucosa by a narrow strip of a very stiff blotting paper inserted in the nose, a clear liquid trickled from the end of the paper into a glass tube. Saline dilutions of this liquid were tested for their power to dissolve a standard suspension of test bacteria (*M. lysodeikticus*) and for their power to kill these bacteria. The average dilution for complete clearing of the suspension in twenty-four hours was 1 part nasal secretion in 1,000 to 4,000 parts of saline solution. This lowest active concentration varied from day to day; sometimes it dropped to 1:250, but it did rise for periods of several days up to 1:250,000. Killing of forty million bacteria brought in contact with various dilutions of nasal secretions for twenty-four hours in the average took place in dilutions between 1:250 and 1:1,000, on some days the highest killing dilution went up to 1:16,000. The curves indicating the daily values for lysis and for killing were parallel.

Without irritation lysozyme could be obtained by washing the enzyme off the surface of the nasal mucosa. In order to obtain comparable results from different individuals on different days an apparatus was used whereby saline or buffer solutions were blown against the surface of the mucosa through a capillary tube. This capillary was enclosed in a wider and 2 mm. longer glass tube, whose opening was pressed against the mucosa; after having been blown through the capillary against the surface of the mucosa the saline solution returned through the wider tube and was collected in a bulb. In this way an equal surface of the mucosa was washed by an equal amount of liquid in day-by-day tests. These nasal washings contained enough lysozyme to be tested by the "cup method" in agar pour plates previously inoculated with test bacteria. This

method gives no quantitative results, but permits estimation of the amount of lysozyme washed off the small surface of the mucous membrane. In this way four individuals with healthy noses were tested day by day over a period of a month. Some individuals showed a higher average lysozyme content in their nasal washings than others. Besides that there were very marked daily variations of lytic power of the nasal washings in all four individuals. The trend of these daily fluctuations was remarkably parallel in all four persons tested. At the same time all of them showed a low content; at another period all went up to a high lysozyme content, although two individuals were confined to bed and two were up and about. If there is a climatic factor involved, there is no relation to the temperature, but there may be a relationship between excretion of lysozyme in the nose and atmospheric conditions connected with sudden fall and rise of the barometric pressure.

In accordance with the studies of Fleming and Hilding, lysozyme disappeared or decreased heavily during the first two to four days of a common cold. At that time *M. lysodeikticus* or other *Sarcina* or spore-bearing rods, which were easily dissolved by nasal secretion from healthy noses, were cultivated from the nasal mucosa or from the nasal mucus, which evidently could not be found in the nose, if lysozyme was present. This lack of lysozyme in a running nose holds true only for the common cold. The discharge from running noses of hay-fever patients showed a high lysozyme content. The absence of lysozyme cannot be considered as proof of a causal connection between this affection and lysozyme.

XXIII

TYMPANIC CAVITY IRRIGATION

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The process presented here is reversed from the customary method of treating the tympanic cavity, eustachian tube, and nasopharynx. Various methods for introducing medication through the eustachian tube into the tympanic cavity have been described and used in the past years. The process, however, employs medication directed from the external auditory canal through the tympanic membrane, tympanic cavity, and eustachian tube into the nasopharynx in the form of irrigation. If such a process has been used in the past it has never been reported and has not been used extensively. It has been routine in my practice for ten years with very satisfactory results.

The nearest approach was reported by Reid in 1939.¹ In this article no mention was made of recovering the fluid in the nasopharynx.

It seems necessary to differentiate the tympanic cavity from the middle ear since the term *otitis media* has led most men to refer to the tympanic cavity as the middle ear. Anatomically, the middle ear also includes the cells, antrum, and aditus of the mastoid process. Although irrigation of the tympanic cavity may draw debris from the mastoid region there is no intent of trying to irrigate this area.

The method consists of forcing a thin fluid from the external auditory canal through a perforation in the tympanic membrane into the tympanic cavity and on down the eustachian tube into the nasopharynx. The medicine should first be warmed, and then with the patient's head tilted to the opposite side, the lower or inner one-third of the canal may be filled with the fluid. By means of a Siegle otoscope sufficient pressure may then be exerted so that the fluid will be seen to disappear through the perforation in the tympanic membrane. At the same time a bubbling sound will be heard at the nasopharyngeal mouth of the eustachian tube. If there is any question as to the patency of the tube, air may be tried first, since it will produce the same sound. The Siegle otoscope will need a piece of rubber tubing on the tip so that a complete, firm contact

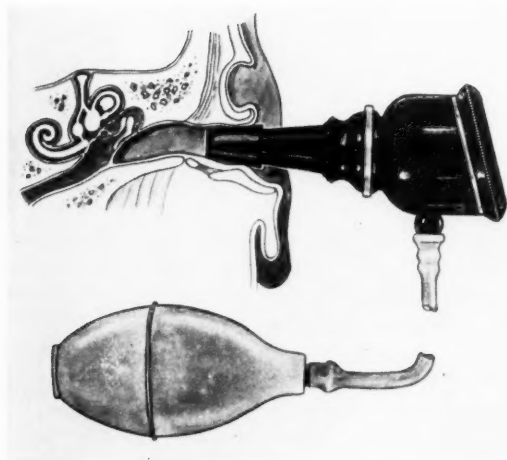


Fig. 1.

will be made at all points around the external canal. A black, hard rubber otoscope works best, since there is less reflected light and the angle allows one to see better what is taking place. There is usually a plug of mucus or pus in the tympanic cavity or eustachian tube or in both which will need to be forced out ahead of the medicine. It takes a little more pressure to push this plug out than it does to force the medicine through. When considerable débris is encountered in the external canal, aspiration and mopping should be employed until the majority has been removed. Especially in chronic otitis media careful otoscopic examination and thorough cleansing of the external canal and tympanic membrane are necessary before trying to force anything through the tract outlined. If polypi, excessive granulation tissue, or foreign body be present, no such procedure as described above should be attempted.

This method was first found to be useful in cases where there was a long-standing perforation which allowed each new infection in the nasopharynx to creep up the eustachian tube and involve the tympanic cavity. These patients have no discharge from their ears during the summer and discharge often clear up between attacks in the winter. They are afflicted by infection covering only the tract already outlined and have no complicating acute mastoiditis.

There is also a group of patients who have a large perforation or complete absence of tympanic membrane, but who still at times complain of a stuffy feeling in their ear. Upon examination the mucous membrane which lines the tympanic cavity may be seen to be dry and healthy and the eustachian tube may appear well open. There is usually some congestion in the tube with a plug of mucus. These patients do better when treated as outlined above than when air is blown up the eustachian tube in the usual manner.

The same process has been used in acute infections of the tympanic cavity where spontaneous rupture has taken place or paracentesis has been done. In otitis media without complication of mastoiditis, where there has been no previous perforation, more treatments may be necessary depending upon how well the nasopharynx responds. However, very good results have been attained with one or two treatments, without producing mastoiditis.

A few patients, in whom the perforation is located superiorly and connects with the epitympanic space, have been helped greatly by forcing fluid through this area. Often a slowly necrosing ossicle in the attic may keep up a discharge for some time. In some of these cases fluid would not pass through the perforation. If this type of perforation leads to the mastoid, no fluid will pass and no benefit may be expected.

There have been no detrimental effects or complications from this method of treatment. Many opportunities have arisen to observe mastoids by X-ray before, during, and after this method of treatment, and no case has been encountered where mastoiditis has developed from the procedure, and no cases have been observed where the inner ear was injured.

The possibility of causing trouble with pressure is very small. The force to be developed by the usual bulb in a Siegle otoscope is much less than that used in inflating an ear by means of a Politzer bag or in doing a fistula test.

The thinner the fluid, the better and more easily it will flow. Aqueous solutions are less painful than alcoholic. There seems to be some selection of solution in reference to the specific germ, therefore, the actual drug used needs to be changed at times, particularly when the germ of an epidemic changes morphology. At times, I have thought simply the mechanical process of cleaning the tract to be of more value than the germicidal affect of the drug, particularly when recovery is spectacular.

There are several advantages to the form of treatment described.

1. There is no pain associated with the process, which makes it very useful in children, for even when the child is difficult to manage, the treatment may still be accomplished.

2. There is no need to disturb the nose in order to reach the eustachian tube as is necessary for inflation, which is greatly advantageous, especially in treating children.

3. The direction of flow of the fluid is the same as the action of the cilia that line the tube and aids greatly in restoring normal function to the entire mucous membrane.

4. The nasopharynx is treated at the same time. Since the tract usually becomes infected from the nasopharynx, it is highly advantageous to have this area recover at the same time.

When a discharging ear which has been treated in this fashion returns to normal and remains so, there is evidence that no mastoiditis has accompanied it. However, if the ear again starts discharging without an intervening infection or never stops discharging, there is evidence that more area is involved than that outlined.

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Clinical Notes

XXIV

THE PROBLEM OF A COMMON PIN AS A FOREIGN BODY IN A TERMINAL BRONCHIOLE

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SYDNEY, AUSTRALIA

The problem of a common pin as a foreign body in some part of the bronchial tree may be a simple matter to the trained bronchoscopist if the intruder can be seen. If it be pointed downward, it can readily be removed with the point trailing and will do no harm. If it be pointed uppermost, there may be some difficulty in freeing the point from impaction in the bronchial wall. By combined movements of rotation and downward pressure the point can be freed, however, and then, sheathed in the mouth of the bronchoscope, the pin can be removed without harm. Only too often, however, the problem is more trying than this. Owing to its narrow diameter, a pin falling with its blunt head downward will often pass into the smallest of distant bronchi, where it comes to rest beyond even bronchoscopic vision and in a space so small that manipulations, in the way of rotation or further down-pressing to release the point, are impossible. In such a case as this, which I herewith report, the difficulties are many and each must be overcome in turn to achieve success. The description of the procedure to be found in the standard works on bronchoscopy and the foreign body is sufficient to give an understanding of the basic mechanics to be applied, but unless one has worked on an actual case he will find that there are many further details which present themselves only as repeated attempts are made in an actual case. Jackson makes the encouraging statement that any localizable foreign body which has gone down the bronchial channels can be brought back the same way; not the first time perhaps, but possibly after the third or fourth endeavor, especially if each succeeding effort be supported by concentrated thought and planning. Thus three aspects of the problem had to be considered in my case:

1. The pin itself was beyond bronchoscopic vision. Biplane fluoroscopic X-ray therefore was necessary for the guidance of the

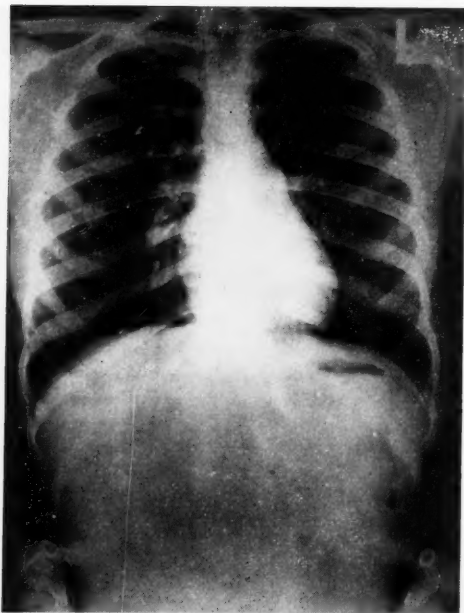


Fig. 1.—X-ray showing pin lying in patient's right lung.

bronchoscope and instruments to the exact site of the foreign body. We did not have at the Sydney Hospital the specially built X-ray apparatus, as devised by the Jackson Clinic, but we managed with some improvisation of the hospital's existing equipment. Our tubes were much nearer the patient than in Jackson's apparatus and we could use the X-rays for only a very limited period of time on each occasion and then had to wait for about three weeks before it was safe to expose the patient to the rays again.

2. The best form of anesthesia had to be found by trial. At the first two examinations, oxygen bubbled through chloroform was employed, but this either failed to maintain sufficient depth of anesthesia to control coughing or if pushed it caused such an unpleasant draft at the bronchoscope mouth that the surgeon was greatly impeded in his work. Other drugs and methods were considered, but local anesthesia combined with morphine and hyoscine premedication

proved so satisfactory that this method was employed at each subsequent examination including the final and successful approach to the foreign body. Since good anesthesia definitely did contribute to the success finally achieved, the technic followed is recorded. The premedication comprised morphine, gr. 1/4, with hyoscine, gr. 1/150, two and one-half hours before operation, followed by a second injection of morphine, gr. 1/6, with hyoscine, gr. 1/300, given one-half hour before operation. With this sedation the patient was drowsy but awake and cooperative throughout subsequent instrumentation. Decicaine, 2 per cent, diluted with one-third part of adrenalin 1/1000, was used for local anesthesia. First the mouth and pharynx were sprayed with this solution, care being taken to include the upper gums. Next the hypopharynx and larynx were reached with curved wood applicators, and then, gaining indirect vision with mirrors, a curved dropper attached to a syringe was employed to drop some of the solution onto the vocal cords and down into the trachea and bronchi. Adequate time was allowed to elapse between each stage of anesthetization, in all a good twenty minutes. The bronchoscope was then passed into the trachea and further applications were made to the tracheal and bronchial walls. This was absolutely essential to suppress coughing. Indeed, at the first two trials, when we found it a problem to identify the precise bronchiole containing the foreign body, it was realized that failure was due to delay caused by coughing, excited from contact with the distant bronchioles, and in the end it was found essential to suppress the reflexes even from these parts by swabbing and patiently waiting for the anesthetic to act.

3. Our own equipment comprised a variety of bronchoscopes and forceps. Our finest long bronchoscope, however, was a 7 m. by 50 cm. tube. With this it was possible to reach down to the medial terminal division of the main bronchus of the lower lobe, but not into the medial bronchus itself. One could look down into this bronchiole and pass straight forceps into it. X-rays then established that a fine forceps passed close to the point of the pin, but, going further down, seemed to pass away from it. It seemed that the pin must be in a smaller bronchiole again branching off the medial terminal bronchus. Once or twice we could catch a glimpse of a semilunar section of the opening of a small bronchiole passing laterally from the medial terminal bronchus. Here we were convinced of the necessity of securing a still finer bronchoscope, and one of adequate length, in order that the medial terminal division of the main bronchus to the lower lobe might actually be entered and the branch bronchioles passing off might be viewed and then brought



Fig. 2.—Pin-bending forceps.



Fig. 3.—Pin-bending forceps grasping and bending the pin.

into a straight line to permit the insertion of fine straight instruments. When this was done, a straight pin forceps was passed into the little lateral branching bronchiole. On one occasion the pin was grasped, but the point was impacted and withdrawal of the intruder was impossible. The pin-bending forceps devised by the Jackson Clinic was known to me from reading, and it seemed that this forceps, especially designed for such a case, offered the only solution. After searching hospital and private equipment in several capital cities in vain, our only resort was to cable the makers of the Jacksons' instruments in America to send the forceps by air mail. This was done and after four weeks we were able to proceed again. First, to gain familiarity with the working of the forceps, fine rubber tubes were affixed to a board and a pin was placed inside the tube in a position resembling that of the pin in the patient. We watched the forceps at work both by naked eye and with X-rays, learning that the forceps with their markedly in-turned toothlike blades would very readily over-ride a pin. The problem was to cause one blade to pass behind the pin. It was found on the rubber dummy that if the projecting blades were passed down to and just touching the center of the pin, but not overlapping it, by a rotating movement of the whole instrument, the posterior blade could be made, after one or two trials, to slip behind the pin, and then, if returned to the anteroposterior position, the shaft could be hooked by this posterior blade. After this, closure of the handles caused the pin to be drawn up so that it came to lie at right angles across the mouth of the forceps tube; thereafter bending of the pin was affected by tightening up with the butterfly screw on the handles of the instrument.

The history of our patient is as follows:

V. K., aged 16 years, while removing pins from old clothing at her work, thought she had accidentally swallowed one. X-rays revealed, however, that the pin had lodged far down in her right lung. Bronchoscopic examination demonstrated that the pin was beyond direct vision. Steps were taken, therefore, with X-ray so that instruments might be guided by screening with both a lateral and an anteroposterior view. The patient was subjected to bronchoscopic efforts under the X-rays on six successive occasions. After patient local anesthetization, a 6 mm. by 35 cm. Jackson bronchoscope was inserted, and as had been planned, a good view of the branching bronchiole passing laterally from the medial terminal bronchus to the lower lobe was obtained. A fine straight forceps was passed into this opening with the object of using it as a guiding probe to deter-

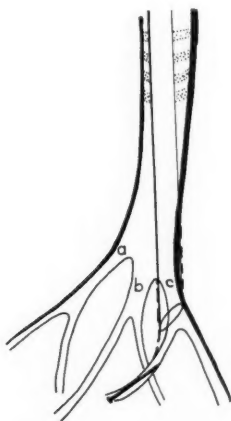


Fig. 4.—Drawing to show how a long fine bronchoscope was necessary to give direct vision of the opening of the small bronchiole containing the pin. Dotted lines indicate how the fine bronchoscope, by straightening and dilating the passages, caused the opening of lateral branching bronchiole to be brought directly into view. Larger bronchoscope could only be introduced as far as point marked *c*.

mine definitely that this was the site of lodgement of the pin. The X-ray screens, both lateral and anterior, confirmed that we were touching and moving the pin. The anesthetic was adequate, and there was no coughing when the fine forceps were removed and we were able to keep the tiny bronchiole in view. The pin-bending forceps were passed down but engaged rather firmly at the entrance to the little bronchiole. With gentle sustained pressure, however, the tubular end was made to pass onward, jumping twice as if cartilage rings or ridges were overcome. The X-ray screens were illuminated, showing contact with the pin. The blades of the forceps were opened. It was seen that the pin had been engaged on the second rotating movement. The blades were closed. The pin came quite easily to a right angle across the tube mouth. Finally, we watched the pin bending on the X-ray screen until it was converted to an inverted U with both point and head trailing. Withdrawal was easy, and at last, after nearly six months of planning and repeated trial, the foreign body was recovered.

In the early stages the patient suffered no inconvenience from the presence of the metallic foreign body. After about one month

she had developed a slight cough and a few rhonchi could be heard with the stethoscope. Thereafter her cough continued and at each subsequent bronchoscopic examination a little pus could be seen in the medial terminal bronchus of the right lower lobe. There was no bleeding on any occasion, and since removal of the foreign body her cough and chest signs have gradually passed away.

I have gone to some length to describe the procedure in this case as too little detail is given of the process, and a detailed description of the process should be on record for guidance of others. At the same time, we realized the debt owed by the world to the study given to these problems, especially by the Jacksons and their colleagues in Philadelphia, and for the ingenuity which has resulted in the development of instruments specially adapted to the individual problems of the variety of foreign bodies and the difficult locations where they may come to lodge. We wish to thank Dr. H. S. Kirkland and Dr. R. S. Godsall for considerable assistance and advice, and also the X-ray and operating room staff of Sydney Hospital.

SUMMARY

1. The common pin, forming a foreign body in a terminal bronchiole, provides a problem calling for ingenuity in the study of the mechanical difficulties brought about by the nature of the foreign body itself and the site and manner in which it lies.
2. Biplane fluoroscopic guidance must be provided and a variety of bronchoscopes of sufficient fineness, but of adequate length, and suitable, fine long pin-grasping forceps and Jacksons' pin-bending forceps must be available.
3. Local anesthesia, supported with adequate preoperative sedation, is the most satisfactory form of anesthesia, but it is necessary to carry the anesthetic down to the terminal bronchi.
4. The operator, when he fails at one attempt, must reason out the causes of failure, correct the shortcomings, and try again and again.
5. As Jackson says, with rare exceptions, foreign bodies, sooner or later, after repeated trials if necessary, can all be removed by endoscopic methods.
6. Jacksons' pin-bending forceps, more than any other of the instruments, has contributed to the solution of the problem of the safe removal of the common pin at the periphery of the lung.

XXV

SCARLET FEVER, BILATERAL MASTOIDITIS WITH INTERVENING PNEUMONIA AND CEREBELLAR ABSCESS WITH RECOVERY*

ROBERT B. LEWY, M.D.

CHICAGO

The patient, R. L., a boy 4 years of age, was admitted to the Municipal Contagious Disease Hospital Aug. 26, 1940, with symptoms of one day's duration. He was acutely ill, with a temperature of 102.4° and a diffuse fine papular rash. There were a few palpable, firm, and slightly tender cervical glands, and there was slight redness in the posterior superior third of both the right and left membranæ tympani. The hearing was normal. The face was flushed and there was circumoral pallor and "strawberry tongue." A diagnosis of scarlet fever was made.

At the time of admission the urine examination was negative, but during his long stay in the hospital (Aug 26, 1940, to Jan. 11, 1941) he twice showed 1+ albumin, once 2+, and once 1+ sugar. On two occasions pus cells were seen. During the earliest days of his illness he had a slight nasal discharge. On the tenth day the temperature approached normal.

On the twenty-first day of the disease he developed a left earache, and the temperature rose to 102.4° rectally. There was a slight mastoid tenderness and earache which was followed shortly by aural discharge. He was given 40 gr. of protylin daily. The ear discharge stopped two days after the onset, resuming profusely again on the twenty-sixth day with recrudescence of low-grade temperature. On the thirty-second day of the disease the patient had emesis after two of his meals. The left ear continued to discharge. Pain developed in the right ear to be followed shortly by discharge of purulent material. Bilateral discharge continued. On the forty-sixth day of the disease, after some considerable discussion which I will touch upon later, a left mastoidectomy was performed. The pathology found was necrosis of the inner portion of the mastoid bone with granulations in the region of the mastoid antrum. The vitreous plate over the dura and the lateral sinus was intact. Three days after the operation there was still fairly marked discharge from the left ear and a sustained elevation of temperature. There was also a marked discharge from the right ear.

The question then arose as to the cause of the continued temperature, and it was felt that the source lay most probably in one of three places: the right mas-

*Presented before the Chicago Laryngological and Otological Society, April 7, 1941.

toid, the urinary tract, or the lungs. Physical examination revealed a little difference in the breath sounds, and at the angle of the right scapula there was slight bronchial breathing. Blood culture was negative. In the opinion of the roentgenologist the chest plate showed some slight pneumonia. The question then arose as to whether the right mastoid or the pneumonia was causing the fever, and whether the mastoid did not predispose to a continuance of the pneumonia by lowering of the general resistance of the patient.

On Oct. 19, 1940, the fifty-sixth day of the disease and twenty-four days after the onset of the discharge from the right ear, right mastoidectomy was done under local anesthesia. Immediately postoperatively the temperature rose to 104.4° rectally, but it was within normal range four days postoperatively. Then the temperature began to rise again to 101° on the sixty-second day and on the sixty-third day ran as high as 104.8° , then fluctuated between 104.4 and 100.8° for three days and gradually subsided to a normal range by the seventy-first day of the disease. After three or four days, however, it went up to 100.2° and after the eighty-fourth day it returned to normal and the patient seemed well on the way to recovery.

Shortly following this the patient became nauseated, complained of some headache, had an occasional emesis, but temperature, pulse, and respiration remained normal. Neurologic examination at this time revealed a definite ataxia of the left hand and leg, and jerking nystagmus to the right. He was conscious and cooperative. Because of the vomiting, nystagmus, and ataxia it was felt that there was a lesion in the left posterior fossa either of an extradural or intracerebellar nature. There was some doubt as to whether the lesion was a cerebritis or an actual necrosis and in the light of the patient's good condition and the desire to wait for capsule formation of an abscess if one were present, it was decided to postpone surgery. Two hours later the child was examined by a neurologist who concurred in the localization of the diagnosis and recommended drainage of the cerebellum by the suboccipital route after trephining the opposite side of the skull and removing the spinal fluid from the lateral ventricle. One hour after this the patient lapsed into coma.

Because of the rapid advance of his condition, it was felt it was impossible to delay surgery. With a very slight ether narcosis the area over the level of the cerebellar hemisphere was exposed. The dura looked slightly grayish and did not pulsate. A crossed incision was made in the dura and a Cushing needle inserted into the cerebellum. In the first five areas of insertion no pus was found but the sixth time the abscess was found and a large amount of thin gray-green fluid escaped through the needle. A rubber tube was slipped in to replace the needle and was sewed into place. One and one-half weeks after the operation the tube was allowed to extrude itself gradually. After a stormy convalescence the patient finally recovered and was discharged from the hospital on January 11, five months after admission.

COMMENT

The conduct of this case was of particular interest not only because of the gravity of the situation and its fortunate outcome, but because important decisions had to be made; and there was not infrequently disagreement among the clinicians as to what should be done, when it should be done, and how it should be done.

First, since the mastoidectomy was definitely indicated on the left ear and the right ear had discharged less than two thirds as long, it had to be determined if surgery should be performed on this ear as well. We finally decided to operate upon the left ear and to judge by the degree of necrosis and coalescence of the bone, as well as the condition of the vitreous dural and sinus plates, whether we should perform the operation on the right ear. The pathology found was adequate to justify operation on the left mastoid but did not indicate that the inflamed mastoid bone on the right side of the patient was adequately necrosed and localized for surgery. Therefore, we decided to hold off on the right mastoid until either adequate time had elapsed for localization and coalescence or operation was forced by some intercurrent condition.

Second, we had to establish the cause of the continued temperature after the first mastoid operation. In investigating this we found two possibilities, either or both of which could have been the cause: (1) pneumonia and (2) the aforementioned continued right mastoiditis.

Third, we had to decide whether the right mastoid was perhaps responsible for the continuance of the pneumonic process and whether it should be operated upon in order to get the patient well, or as the pediatrician held at that time, whether surgery on the mastoid would further lower the patient's resistance and thereby increase the risk. We finally decided to perform mastoidectomy under local anesthesia. The subsequent favorable course of the pneumonia and the right mastoid, up until the time of the development of the left cerebellar abscess, seemed to justify our reasoning on this particular point.

Fourth, we had to determine when to operate upon the cerebellar abscess. This was solved by the rapid progress of the lesion and surgery was done the same day that the diagnosis was established because of the comatose condition of the patient.

Fifth, it was decided to violate the recommendation of the neurologist in the case who felt that trephining should be done on the side opposite to the abscess in order to drain the ventricle and suboccipital approach made into the abscess. Instead of this the mastoid opening was enlarged to uncover the dura over the posterior fossa and the abscess was drained directly from this area. It was felt that the patient's condition made the simplest type of surgery of urgent necessity, and that the additional time on the operating table from all of these recommended procedures might possibly prove fatal. It was also felt that it would perhaps make it easier to find the abscess

if there were more intracranial pressure and once the abscess was tapped, the pressure would have a tendency to collapse it and thereby aid in healing.

Sixth was the question of the use of sulfanilamide after the abscess was diagnosed. We felt there was everything to gain and nothing to lose. And that since in the characteristic pathology of the abscess there is a very vascular wall, large quantities of sulfanilamide would deposit in this region and might prevent progress while nature had a chance to heal. With this idea in view 140 gr. were given per day.

25 E. WASHINGTON ST.

XXVI

CAVERNOUS HEMANGIOMA OF NOSE, NASAL SEPTUM AND FOREHEAD*

SAMUEL SALINGER, M.D.

CHICAGO

This report concerns a young lady, 20 years of age, who came to see me on May 5, 1937, for the relief of an oversized nose which her mother stated had been present from birth. There had been no subjective symptoms aside from frequent nasal bleeding of spontaneous origin. The patient also stated that the nose seemed to become larger with exercise and to recede slightly on lying down.

Examination revealed a smooth enlargement of the lower half of the nose which was of a bluish purple color and elastic to the touch and which extended almost to the level of the lower border of the nasal bones. The lower portion of the septum was also of the same color and consistency and bulged into the nares, both of which were thereby almost completely obstructed. The mucous membrane covering the septal swelling was very thin and there was a slight pulsation on palpation. The entire mass was easily compressible both externally and within the nose and felt warm to the touch.

On the forehead slightly to the left of the midline there was a similar mass extending from the hairline down almost to the supra-orbital margin. While the color was very much like that of the nasal swelling, the mass felt somewhat more dense. However, it seemed that the growth was very vascular because it could be reduced to a large degree and caused to blanch by pressure.

Because it was apparent that the masses were angiomatous in nature it was deemed inadvisable to attempt any surgery which would certainly be attended by severe hemorrhage and would also lead to serious deformity. The patient was therefore referred to the Michael Reese Hospital tumor clinic where she was seen by Dr. Max Cutler who advised interstitial radiation. Accordingly in May, 1937, she

*Presented at the joint meeting of the Milwaukee Eye, Ear, Nose and Throat Society and the Chicago Laryngological and Otological Society, Milwaukee, March 11, 1941.

received 500 mg.hr. of radium through ten needles inserted through the skin. Following a period of rest, during which time the mass receded slightly, she was again treated in the same manner (240 mg.hr.). A third radium treatment was given in February, 1939, consisting of five needles for a total of 120 mg.hr. which resulted in a considerable reduction in the size of the nose as well as its color. However, the septal portion of the growth remained practically unchanged and it was decided, therefore, to treat it more directly. On June 1, 1939, two needles containing 1 mg. of radium each were inserted into the right side of the septum and one needle into the left side. Also three 2 mg. needles were imbedded in the lesion on the forehead. The dosage at this sitting was 72 mg.hr. for the septum and 216 mg.hr. for the forehead.

When examined on Nov. 24, 1939, it was apparent that the vascularity of the masses had been greatly reduced. It was, therefore, felt that a plastic procedure could be safely undertaken at this time since the nose was still too thick and bulbous and the forehead still presented a conspicuous prominence. Also there were several unsightly pit marks on the nose caused by the radium needles which the patient was desirous of having eliminated.

On Jan. 31, 1940, surgery was performed. The mass on the forehead was excised in toto with the overlying skin and the defect closed by undermining the adjacent skin which was brought together with tension sutures. There was considerable bleeding during the operation and the mass was found to extend down to the periosteum. At the same time the bulbous nose was reduced by two parallel excisions of skin and underlying stroma on both sides of the nose from the level of the lower border of the nasal bones to within a few millimeters of the alar margins. The adjacent skin was undermined and brought together with interrupted sutures. The resulting scars were not entirely satisfactory and were resutured a short time later with much better cosmetic results. However, at the present time there are still a few pit marks which are quite noticeable and which I expect to excise at some future time.

Histologic examination of the tissue removed from the forehead did not indicate the true nature of the original growth because of the effect of the radiation therapy. It showed a large amount of fatty tissue irregularly distributed throughout the stroma, some muscle tissue, and a large number of blood vessels showing various degrees of hyalinization. Undoubtedly these vessel changes were due to the radium. The presence of masses of fat in this location is an interesting finding. One could hardly call it a lipoma because



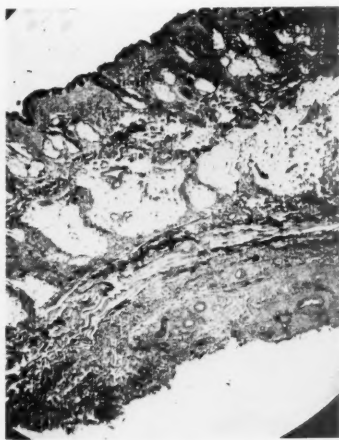
Fig. 1.—Cavernous hemangioma of nose and forehead. Front view before and after treatment and surgery.



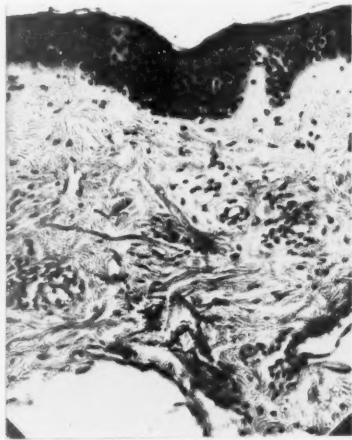
Fig. 2.—Profile before and after treatment with surgery.



Fig. 3.—Congenital fatty tumor of forehead associated with absence of left nasal bone and incompletely developed ala nasi.



A



B

Fig. 4.—Sections of mass removed from forehead after irradiation. No sign of tumor tissue. Numerous vessels showing hyalinization. Also masses of fat. A. Low power; full thickness of mass. B. High power.

of the diffuse and irregular distribution of the tissue and because lipomas are not usually found at birth. I believe it indicates a developmental anomaly, of which I have seen two similar cases, one of which was associated with absence of one nasal bone and incomplete development of the corresponding ala nasi. (Fig. 3.)

A discussion of the embryological factors leading to the development of these anomalies would lead us too far afield. I am reporting the case because of its comparative rarity and to demonstrate the value of preliminary irradiation for the reduction of the vascularity of these otherwise inoperable tumors. It must be pointed out in this connection that there is no other form of therapy that could be applied to a hemangioma in this location with the possible exception of electrodesiccation through intramural needles. Surface irradiation, while successful in the treatment of superficial angiomas of small size, could have little effect on a deep-seated vascular growth unless applied in such doses as to endanger the integrity of the overlying tissues. Surgery alone would have to be so extensive as to involve the sacrifice of a great deal of skin and cartilage causing a deformity that would necessitate considerable subsequent reconstructive work.

25 E. WASHINGTON ST.

ARRESTED DEVELOPMENT OF THE LARYNX
FOLLOWING IRRADIATION FOR RECUR-
RING PAPILLOMAS*

SAMUEL SALINGER, M.D.

CHICAGO

A young man, 21 years of age, was first seen at the age of 3 years. He was brought to the clinic wearing a tracheotomy tube which had been inserted a short time previously because of dyspnea supposedly due to diphtheria. Direct laryngoscopy, however, revealed a larynx filled with soft papillomas. During the next two or three years these growths were removed a number of times with only temporary relief. However, the airway was sufficiently established to permit removal of the tracheal cannula and closure of the fistula. A year later, the growths continuing to recur after removal, he was subjected to external irradiation with radium which resulted in a burning of the skin and intralaryngeal swelling necessitating a second tracheotomy. A year later, when 6 years of age, his larynx appeared stenosed in the subglottic region and a tracheostomy was performed followed by the introduction of a Schmiegelow tube. The tube was tolerated for about a month when it was removed and the stenosis treated by retrograde dilatation for a year. By the time the boy had reached puberty the stenosis was well dilated and the papillomas had practically disappeared. It must be noted, however, that all in all he had been subjected to at least forty operations for removal of the papillomas, all done under direct laryngoscopy with blunt forceps.

The patient was not seen again until several years later when he was 16 years old. At this time he had grown considerably and it was observed that not only was the skin over the front of his neck atrophic and telangiectatic, but that the prelaryngeal muscles and the larynx itself had failed to develop. The larynx appeared no larger than it had been several years previously and the largest dilator it would receive was a No. 26 French. There was no web-

*Presented before the Chicago Laryngological and Otological Society, Monday, Oct. 6, 1941.



Fig. 1.—Tracheostomy before closure. Note atrophied and telangiectatic skin.



Fig. 2.—Tracheostomy closed by transfer of tube flap from the chest. Note adherent atrophied skin at base of neck (to be replaced by tube flap from back).

bing within the larynx or trachea, the glottis was unobstructed, and although the arytenoids and vocal cords moved freely, there was an absence of the usually sharp delineation between true and false cords. The epiglottis also had retained its scroll-like infantile shape.

Frequent use of Jackson's metal dilators was successful up to No. 32 French. At this time it was felt that there was sufficient airway for all practical purposes and it was decided to close the tracheostomy. This proved to be a difficult task because of the atrophied state of the skin and poor circulation. However, a tubed flap taken from the chest and swung across the neck eventually developed enough circulation to permit the eventual closure of the opening.

During the course of the following four years it became evident that as the boy grew in size and stature, his larynx failed to keep pace and although he was still able to take a No. 32 French dilator, the airway was inadequate for anything more than simple sedentary pursuits. The situation today is exactly as it was six years ago despite efforts to stimulate the growth of the larynx.

At the present time I am carrying a tubed flap from his back to the neck in order to replace all the atrophied skin at the base of the neck which I hope will release the tension on his pretracheal muscles and permit greater freedom of movement of the larynx. The dilators are still being passed every two or three weeks and he is quite comfortable. The voice is rather hoarse but is audible in a fairly large room.

Reviewing this case in retrospect in an effort to evaluate the factors responsible for the arrested development of the larynx one is forced to conclude that although the tracheostomy may have accounted for some reduction in the function of the larynx during several years of the growing period, it was a minor factor compared to the effects of the radiation therapy which was employed when the child was only 5 or 6 years old. While it is true that cartilage and bone are fairly resistant to irradiation, it is also a fact attested to by numerous observers that irreparable damage may result from the injudicious use of X-rays or radium and that the damage may be not only immediate but also delayed as long as seven years.^{1, 2, 3} At least, complications were quite common in the early days of radiation therapy although in recent times the incidence of complications has been greatly reduced through improved technic. What is more pertinent, however, as bearing on the case reported, is the fact that a child's larynx which is in the state of active growth

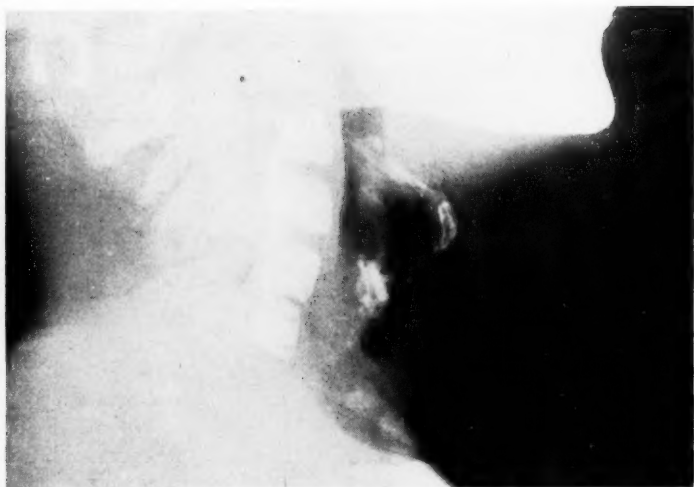


Fig. 3.—X-ray of larynx at present time. Note obliquity of hyoid due to downward pull on muscles of neck by scar, also high degree of calcification and restricted lumen.

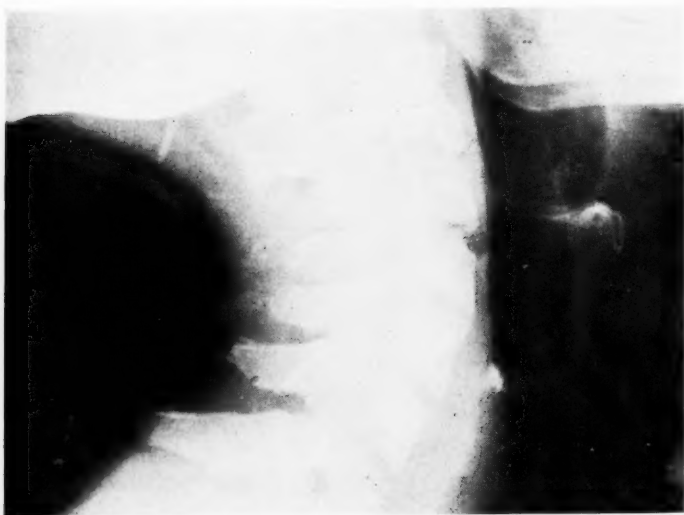


Fig. 4.—Larynx of normal 21-year-old for comparison.

contains cartilage cells of a young and immature type undergoing mitoses such as are not found in the adult state. These cells are definitely less resistant than in the adult and when subjected to irradiation may atrophy and result in arrested development of the entire structure. This, I believe was the case with the young man presented here, for not only is the larynx extremely small for his age and size but the cartilages are definitely distorted as shown in the X-ray pictures. Aside from the fact that the child's pharynx is more sensitive to radiation therapy I believe that this form of treatment has been definitely proved to be valueless for recurring papillomas and has been generally discarded. Whether the recent experience with estrogenic substance will be more efficacious remains to be seen. For the present at least it offers considerable hope.

25 E. WASHINGTON ST.

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Society Proceedings

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Meeting of Monday, October 6, 1941

THE PRESIDENT, DR. JEROME STRAUSS, IN THE CHAIR

Arrested Development of the Larynx Following Irradiation For Recurring Papillomas

SAMUEL SALINGER, M.D.

(This paper appears on page 273 of this issue.)

DISCUSSION

DR. THOMAS GALLOWAY: I am rather disappointed that Dr. Salinger did not discuss a very interesting problem, the mechanism of growth of an organ like the larynx. Cartilage grows interstitially by increase in number and size of cells and development of membrane between them, and also perichondrially. What happens to determine failure to develop after irradiation or injury? Is it injury to chondroblasts or of supporting structures, or both?

Previously, when radium and X-ray were used in too great doses or without sufficient screening, the rays did much damage. But Foster has shown that when they are used in sufficiently small doses, repeated if necessary, they can destroy papillomas and not injure the cartilage.

In a case of mine, similar to that of Dr. Salinger's, a boy came in with a diagnosis of diphtheria. He had had some twelve operations and some radium applications. He required an emergency tracheotomy and the larynx was completely filled with greyish masses. I operated upon him repeatedly with cup forceps, and desiccated the base of the papillomas with diathermy, which seemed to prevent recurrence. From 1929 to 1931, I did everything possible to keep open an airway including core and tube dilatations, but he did not

get much better. He did have a partial airway. Then I stopped doing anything about the time of his adolescence and much to my astonishment the larynx started to grow, and the airway widened until it was adequate and the laryngostomy could be closed, and the papillomas did not recur.

I think in most cases one must blame also the operative interference as well as irradiation. If one destroys the perichondrium the growth of the larynx will be affected. The use of sex hormones in such cases is interesting and, if its promise is borne out, we may be spared such trials as these cases have been. They are certainly not common.

DR. PAUL HOLINGER: Dr Salinger has certainly presented an interesting case. Cases observed over a long period, as this one has been, are extremely instructive. I hope Dr. Salinger will report it in full, because radiologists who treat these cases are pleased with the immediate results obtained in the treatment of papilloma of the larynx, and do not see the patient years later when destruction or failure of growth of the larynx manifests itself. The fallacy of an apparent immediate cure is perfectly illustrated.

DR. GLENN J. GREENWOOD: The case I speak of is a boy aged 7 years with recurrent papilloma, whose mother is a very intimate friend of a doctor whom I know very well. Though everything was coming along all right, the physician desired us to use testosterone propionate. Realizing that he was progressing satisfactorily I was loath to do so, also because of the fact that heretofore it had been reported of little value. Holt cited two cases in which it had been of no value. Nevertheless, I was urged to try it. For about eleven weeks now the boy has had intramuscular injections of this preparation; the first two weeks he had 75 units; for the next five weeks, 50 units; and for the last four weeks, 25 units. He weighs, I should estimate, about 50 pounds. I looked at him five weeks ago last Friday and much to my surprise the larynx was more red throughout; the papillomas previously present appeared to be much paler and firmer in consistency. I did not remove any at that time. Last Friday I looked at him again and the picture had changed very little. The papillomas were not growing noticeably. I did, at this time, remove a fragment from the subglottic region. In view of the previous unfavorable reports, I was surprised at the result. We thought at one time that we would use an amniotic spray, but have not done so because of the result we are apparently obtaining. His voice has appreciably improved. The genitals have

increased considerably in size. The administration of the drug is under the supervision of one who is experienced in this field.

DR. ALFRED LEWY: I wish to report two cases, apparently spontaneously cured, of multiple papillomas. The first was a school boy in whom, after several postoperative recurrences, the papilloma spontaneously disappeared at the age of 15 years.

The other boy I first saw at the age of 19. The first surgical removal, which was supplemented by immediate application of electrocoagulation, was promptly followed by recurrence with implantations at new areas. After the second partial removal of the recurrent growths this young man entered the University of Arizona at Tucson. I next saw him about six or seven months later. The voice was perfect and there was a mild suggestion of irregularity on one of the ventricular bands, which may have been a remnant of the papilloma.

Both of these boys had, as local treatment following operation, a spray of thuja, as recommended some years ago by Fletcher Ingals. In both cases the cure was so slow that I am somewhat skeptical about the influence of the remedy.

DR. FRANCIS LEDERER: As the main premise of Dr. Salinger's paper concerns the stenosis of the trachea, the thought occurs to me that tracheotomy may have some bearing on the condition. I have two reasons for bringing this up; because of the possibility that in doing tracheotomy in infants, and from the description of the stenosis occurring low down, apparently subglottic, this may be the result of the tracheotomy being performed too high up, near the cricoid. If this was not true in this case, nevertheless we know it does happen. The past history of this patient was indefinite. It was thought to have been a case of diphtheria. Might not one also think that tracheotomy could cause a foreign body reaction? The tissue in some of these reactive cases does not differ greatly histologically from true papillomas. The reason for mentioning this point is that we have witnessed cases where tracheotomy did act as a foreign body and did induce such a local reaction as that described by Dr. Salinger.

DR. WALTER THEOBALD: During the development of the larynx, which Dr. Salinger spoke of as being arrested, was there any arrest in development of the mandible? Also, has he followed the characteristics of the family to learn whether there was any change in the mandible from the standpoint of heredity?

DR. SAMUEL SALINGER: I appreciate the discussion, particularly Dr. Galloway's comment that I might more fully discuss the

development and physiology of the larynx. We know the larynx is not fully developed until adult life, and any agent that stunts the growth of the young cartilage cells must certainly interfere with the development of the entire structure. As to stenosis, we did have a stenosis at the site of the tracheotomy incision which, as I stated before, was fully eradicated. There is no stenosis now except for the constriction of the entire larynx, which is not due to webbing or scar formation. The larynx is merely too small for an adult. If it were scar we would proceed differently, but as the thing now stands no amount of grafting inside the larynx will give us more airway.

The important question that comes to mind now is how we are going to proceed in a similar case if seen as early as the one presented tonight. It is well enough to say that the patient will outgrow his papillomas when he reaches puberty. But if we are going to have to do a tracheotomy so the child can breathe, what will happen to the larynx that is not functioning over a period of years. We know its development will be delayed. On the other hand, repeated removal of the growths carries the risk of trauma to the delicate mucosa with possible distortion due to scarring or the development of a stricture. I have had no experience with the use of surgical diathermy as practiced at the Mayo Clinic nor with insufflation of estrogenic substance as recently reported by Broyles. Nevertheless, should I again be confronted with such a case, I should undoubtedly give amniotin a trial.

A New Plastic Flap for Use in the Endaural Radical Mastoidectomy

GEORGE E. SHAMBAUGH, JR., M.D.

(This paper appears on page 117 of this issue.)

DISCUSSION

DR. ELMER W. HAGENS: About a year and a half ago Dr. Shambaugh demonstrated the endaural radical to us on the cadaver, and shortly after that we operated on the living. Since then I have had occasion to do a small number by this method. I think the flap is a very good idea. I was never satisfied with the flaps as we used to carry them out. It was a very bloody procedure and at the end of a tiresome operation. It is simple to cut this flap with scissors and turn it back. There is no bleeding and it covers more bone than

the older flap. The endaural approach is more direct and easier once the technic is acquired, and it certainly gives a more direct route to the antrum and the tympanic cavity. There are cases, however, where the disease lies so far posterior to the sigmoid sinus that I wonder whether it would be so easy by the endaural method. It would seem more feasible to get to that region with the older method. I think in postoperative care the endaural is easier, and certainly if there is any obstruction you would find it; whereas with the older method there may be an obstruction in the canal which is not found until later.

With regard to cosmetic results, some of the cases do not look as well. When the incision is extended to the suprameatal triangle the scar is in a prominent position.

I have been interested in what seems to be the evolution of the endaural approach. The original technic was to make the incision and then use a bur. Later the bur was not used, and still later the gouge was used over the mastoid process, similar to the method when the incision was behind the ear, apparently going back in some respects to the technic used by the standard post-auricular method.

In some cases I think you have to use the technic that presents itself. It is difficult to say you are going to do a standard radical or a Bondy until you have seen the pathology. X-rays of course are of help, but occasionally they fail to give an accurate idea of the pathology or even the anatomy; so it is best to be prepared to do whatever operation seems to be indicated at the time.

DR. GEORGE WOODRUFF: We have been doing the endaural operation on our service at the Eye and Ear Infirmary for about three years. I agree that the endaural route affords definite advantages in the performance of tympanomastoidectomy as well as atticomastoidectomy. I am much interested in the flap Dr. Shambaugh describes. This procedure, which covers the facial ridge with a healthy skin flap, appears to be of definite value in preventing excessive granulations, thus promoting better and faster healing.

In the Bondy operation another procedure has been used which I believe works equally well or better; that is, the flap employed by Lempert in the fenestration operation. If the attic perforation is not too large, the posterosuperior canal wall can be left attached to the drum membrane and, at the conclusion of the operation, this flap can be folded back to line the attic and antrum area. This promotes rapid healing, just as it does in the fenestration operation.

DR. STANTON A. FRIEDBERG: I have used this flap described by Dr. Shambaugh in four cases, three Bondy and one classical radical mastoidectomy, and can testify to its effectiveness. Dr. Shambaugh indicated that there is a necessity of continuing to spread the endaural incision over a period of several weeks in order to ensure against stenosis of the external canal. There is a definite tendency toward healing, with a certain amount of stenosis of the canal unless this is done. It seems too bad to waste the piece of skin which is removed and discarded when the three endaural incisions are connected, as described by Lempert. In the *Archives of Otolaryngology* for September, 1941, there is a modification by Kettel, in which he employs the Lempert incision but uses the entire posterior canal wall to lay over the facial ridge. This is an attempt to eliminate a tendency to stenosis in the canal, which is doubtless due to the removal of part of the posterior canal wall in the standard endaural approach.

The Presence and Action of Lysozyme in the Nasal Mucus

CARL E. CAHN-BRONNER, CHICAGO

(by invitation)

(This paper appears on page 250 of this issue.)

DISCUSSION

DR. NOAH D. FABRICANT: These are days of national defense; these are also days of nasal defense. Unlike our current interest in national defense, interest in nasal defense began more than a decade ago with the explanation of the importance of the cilia. In time there were studies on the effect of temperature and drugs, and more recently work on the significance of the pH of nasal secretion in situ. Now comes an investigation on lysozyme, which, as Dr. Bronner showed, can conceivably be of practical significance in the future. At present perhaps the significance is limited, and one cannot buy lysozyme at the drug store in the hope of clearing up nasal problems. Nevertheless, the steps taken in this direction may conceivably lead to another great advance in our knowledge of nasal physiology.

I recall the tremendous enthusiasm with which bacteriophage was once regarded. That interest has not completely died out,

although it has been put to sleep until someone can revive it by newer methods. The entire subject of lysozyme may be an equal failure, but time alone will tell.

I was particularly interested in Dr. Bronner's comment on the presence of lysozyme in most individuals, and the fact that it is absent during the first three or four days of the common cold. This finding is a challenge to further work. Hilding, some years ago, very cautiously advanced a similar thesis. Dr. Bronner has been able to confirm his work. The absence of lysozyme during this period explains why it is so difficult to treat a cold during the first two or three days. It is also interesting that individuals with definite vitamin A deficiency show little lysozyme. One must be guarded against erroneous interpretation of this phenomenon. Many individuals do not have a vitamin A deficiency and I feel it would be a mistake to give massive doses of vitamin A to increase the lysozyme content.

I was interested also in the fact that in allergic rhinitis the lysozyme content is high. Perhaps this explains why as a general rule we find so relatively little secondary infection in cases of allergic rhinitis. I would like to ask Dr. Bronner whether lysozyme action is increased by immunization.

DR. CARL E. CAHN-BRONNER (closing): The lysozyme content of tissues or secretions cannot be increased by immunization using material which contains lysozyme, or by using lysozyme which has been more or less purified. There is another question: Can bacterial proteins, after destruction of the bacterial cells by lysozyme, be absorbed by the nasal mucosa so that they act as antigens? I do not know. In immunization, the bacteria must be dissolved in some way in the body in order to act as antigens. Allison has shown that bacteria, after being dissolved by lysozyme, are still antigenic. Bacteriolytic, bactericidal, and complement binding antibodies are formed, but the destruction of the bacteria by lysozyme goes so far that no agglutinins or precipitins appear.

Books Received

Nasal Sinuses.

An Anatomic and Clinical Consideration. By O. E. Van Alyea, M.D., Assistant Professor, Department of Laryngology, Rhinology, and Otology, University of Illinois College of Medicine, Chicago. Pp. xi, 1-262, with 82 ills., 10 in color. Baltimore, 1942, Williams and Wilkins Co. (Price \$6.50.)

This is the most useful book on the general subject of the nasal sinuses which has appeared in a long time. The author lays down with commendable simplicity what is known of the sinuses and documents his theme with an exhaustive list of references and transcriptions. Regrettably he seldom permits himself to inject his own conclusions and the reader is deprived of the rich fruit of Van Alyea's own experience and mature judgment, which he would often find a welcome supplement to the review of published opinion.

This dispassionate presentation probably adds to the worth of the work as a teaching manual, as it gives the individual instructor the opportunity of stressing his own views without impediment.

The exposition is clear, the arrangement is good and the illustrative material is well chosen and well produced. This is a book which the student should read from cover to cover, and the clinician should keep to hand.

Immunity Against Animal Parasites.

By James T. Culbertson, Assistant Professor of Bacteriology, College of Physicians and Surgeons, Columbia University. Cloth, x+274 pages. Columbia University Press, Morningside Heights, New York, 1941. (Price \$3.50.)

There is a gradually increasing literature upon the infection of the upper respiratory passages with animal parasites which will no doubt grow apace with the activity of the various armed forces in the tropics. With this in mind the rhinologist's attention is directed to Culbertson's monograph.

Since the first purpose of the book is to introduce the fundamentals of immunity to parasitic infection to the reader previously unfamiliar with the subject, it will prove especially attractive to workers in other fields. The arrangement and completeness of detail commend it as a reference book.

Sinus.

By Russell Clark Grove, *Chief of the Ear, Nose and Throat Division of the Allergy Clinic, Roosevelt Hospital, New York.* Cloth. xv+165 pages, with 16 illustrations. Alfred A. Knopf, New York, 1941. (Price \$2.00.)

A direct and unemotional exposition of the sinus epic for the edification of the layman with the urge for an objective approach to his pet malady.

Endotracheal Anaesthesia.

By Noel A. Gillespie, *Research Associate and Resident in Anaesthesia, University of Wisconsin; State of Wisconsin General Hospital.* Cloth, xii+180 pages. The University of Wisconsin Press, Madison, Wis., 1941. (Price \$4.00.)

A brisk, readable and highly competent little book. While not essentially a candidate for the otolaryngologist's library, it is a useful reference volume on a subject which touches often and closely upon his own.

The March of Medicine.

New York Academy of Medicine Lectures to the Laity, 1941. Cloth. xiv+154 pages. Columbia University Press, Morningside Heights, New York, 1941. (Price \$2.00.)

Of interest to every physician is this reprint of lectures to lay audiences under the auspices of the New York Academy of Medicine. The present series includes: I. Humanism and Science, II. Paracelsus in the Light of Four Hundred Years, III. Psychiatry and the Normal Life, IV. Philosophy as Therapy, V. The Promise of Endocrinology and VI. What We Do Know about Cancer.

Notices

CONSERVATION OF SCHOLARLY JOURNALS

The American Library Association created this last year the Committee on Aid to Libraries in War Areas, headed by John R. Russell, the Librarian of the University of Rochester. The Committee is faced with numerous serious problems and hopes that American scholars and scientists will be of considerable aid in the solution of one of these problems.

One of the most difficult tasks in library reconstruction after the first World War was that of completing foreign institutional sets of American scholarly, scientific, and technical periodicals. The attempt to avoid a duplication of that situation is now the concern of the Committee.

Many sets of journals will be broken by the financial inability of the institutions to renew subscriptions. As far as possible they will be completed from a stock of periodicals being purchased by the Committee. Many more will have been broken through mail difficulties and loss of shipments, while still other sets will have disappeared in the destruction of libraries. The size of the eventual demand is impossible to estimate, but requests received by the Committee already give evidence that it will be enormous.

With an imminent paper shortage attempts are being made to collect old periodicals for pulp. Fearing this possible reduction in the already limited supply of scholarly and scientific journals, the Committee hopes to enlist the cooperation of subscribers to this journal in preventing the sacrifice of this type of material to the pulp demand. It is scarcely necessary to mention the appreciation of foreign institutions and scholars for this activity.

Questions concerning the project or concerning the value of particular periodicals to the project should be directed to Wayne M. Hartwell, Executive Assistant to the Committee on Aid to Libraries in War Areas, Rush Rhees Library, University of Rochester, Rochester, New York.

GRADUATE COURSE IN CINCINNATI

The Sixth Annual Graduate Course in Otolaryngology will be conducted at the Cincinnati University College of Medicine during the week of May 11-16, 1942. The Course consists chiefly of intensive operative work on the cadaver and is conducted by the Departments of Otolaryngology and Anatomy. Participants are limited to twenty-five practicing otolaryngologists.

